STANFORD
ICHTHYOLOGICAL BULLETIN

Published by the

NATURAL HISTORY MUSEUM OF STANFORD UNIVERSITY

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Volume 4 August 23, 1954 Number 4

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THE OSTEOLOGY AND THE RELATIONSHIPS OF THE SOUTH AMERICAN CHARACID FISHES OF THE SUBFAMILY GASTEROPELECINAE

By Stanley Howard Weitzman

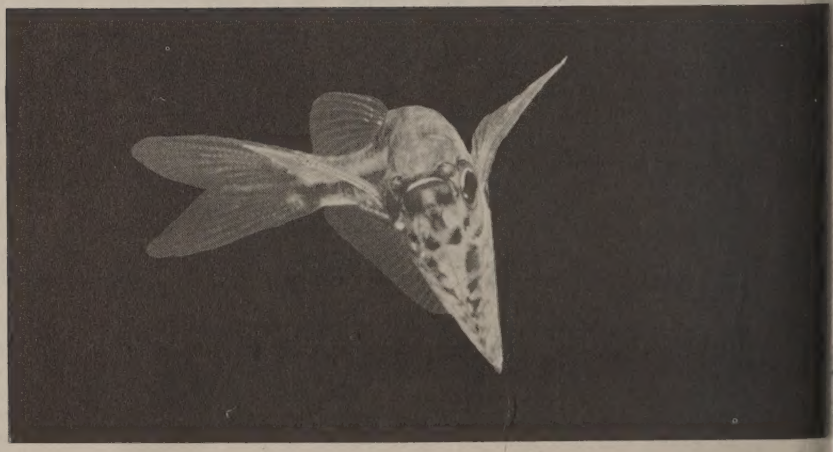
Introduction

Statement of the Problem: The small South American fresh-water characid fishes of the subfamily Gasteropelecinae are perhaps among the most interesting of the members of the large order Ostariophysi. They are the only known fishes which seem to be able to fly in the sense that a propulsive force is used to help maintain velocity while the fish is in the air. Because of their flight habits these fishes have been the subject of several papers in both the scientific and aquarium literature. One of the purposes of the present study is to present a detailed account of the osteology of a single member of this group, in preparation for a study of the flight of these fishes. *Carnegiella vesca* Fraser-Brunner (Fig. 1) was chosen for this purpose since live material is usually readily available on the aquarium market. The known flight and feeding habits are summarized and the characteristic osteological features of this subfamily are listed and compared with the generalized conditions found in relatively primitive living characids. The relationships of the genus *Triportheus* and other characids to the gasteropelecins are treated and phyletic relationships among the genera and species of the gasteropelecins are discussed. Fraser-Brunner (1950a), Fernandez-Yepez (1950), and Hoedeman (1952) have recently treated the systematics of the Gasteropelecinae, and the names adopted by them are used here except as otherwise noted. None of these authors studied the relationships of the subfamily to other characids. For synonymies, these three papers and Myers (1940) should be consulted.

The skeletal structure of the Gasteropelecinae has never been thoroughly studied. Regan (1911) described and figured the primary pectoral girdle of *Thoracocharax securis* (Filippi), mentioned that there is no fontanel in the cranium, and that the frontal has longitudinal ridges. Ridewood (1913) published a photograph of a skeleton of *Thoracocharax stellatus* (Kner) but did not describe its parts. The photograph, although excellent, does not permit examination of the detailed skeletal structure. Hoedeman (1952) republished Ridewood's skeletal photograph of *Thoracocharax* but did not study the osteology of any member of the Gasteropelecinae. Starks (1930) figured and described the primary pectoral girdle of *Gasteropelecus maculatus* Steindachner. Gregory and Conrad (1938) republished Regan's figure of the pectoral girdle of *Thoracocharax securis* and figured the skeleton of "*Gasteropelecus.*" This figure seems to represent *Thoracocharax stellatus*. Gregory and Conrad made no attempt to discuss the detailed osteology of the Gasteropelecinae.

Methods: In evaluating previous work on the osteology of fishes I have often found it difficult to determine precisely what taxonomic unit the author had. When specific or subspecific names are given the matter is usually not difficult, and reference to the literature, to see what was meant by those names at that time, may clarify matters. However, if no locality is given and the name is later found to have been applied to two or more forms, exact determination is sometimes impossible without an examination of the author's material. Use of generic names only may lead to even greater confusion and render the work almost useless for comparative purposes.

A.



B.

FIG. 1. Photographs of *Carnegiella vesca* Fraser-Brunner. X3. A. Lateral view. B. Anterior view.

In order to avoid ambiguity, the complete name and locality of all specimens examined other than gasteropelecins are listed at the end of the section on the relationships of the Gasteropelecinae to other characids. The specimens of gasteropelecins examined are listed in the section on the relationships of the genera and species of Gasteropelecinae. In the discussions that follow, when any genus is stated to have certain characters the specimens of that genus examined were found to have those characters. External features were studied in all material; however, internal structures were investigated only in cleared and stained specimens.

The descriptive osteology and figures of *Carnegiella vesca* presented here are based on seven specimens collected September 30, 1908, by Dr. Carl H. Eigenmann in a woodland brook on Gluck Island, British Guiana (Eigenmann 1909b, 1912). These specimens were selected from 16 specimens that are deposited at the California Academy of Sciences, CAS 20645. In addition, many aquarium specimens of that species were used for practice dissection and as aids in understanding the position and relationships of the bones of these small fish.

Specimens were cleared, stained, and placed in glycerine according to the method of Davis and Gore (1947). Photomicrographs were taken of stained specimens in glycerine on 35 mm. film through one eyepiece of a low power binocular microscope. The image of the negative was projected at the desired size on drawing paper and the general proportions and shapes of the bones drawn from the image. The drawing was then finished from the specimen directly observed under the microscope. It was found that the relationships and sutures of the bones were sometimes difficult to see in the specimens in glycerine. Therefore some stained specimens were dissected free of tissue and dried. In this state their sutures were very clear.

In the lists of material, SU refers to specimens deposited in the Stanford Natural History Museum, CAS to specimens deposited in the California Academy of Sciences, and IUM to specimens formerly deposited in the Indiana University Museum now at the California Academy of Sciences. All figures and photographs were made by the author. A list of the abbreviations used in the figures appears at the end of the paper.

Acknowledgments: Much of the material presented here formed the basis for a thesis for the Master of Arts degree at the University of California. I am indebted to Dr. Paul R. Needham, Dr. Boyd Walker, and Dr. Seth B. Benson of the University of California for critically reading the original thesis manuscript and offering their aid and advice. I am further grateful to Mr. W. I. Follett of the California Academy of Sciences for the loan of specimens from that institution and aid with the literature; to Dr. George S. Myers of Stanford University for informative discussions of characid phylogeny and for critically reading the present manuscript; to Mr. Norman J. Wilimovsky of Stanford University and Dr. L. Ramaswami of Central College, Bangalore, India, for aid on the terminology of fish bones; and to Dr. James Böhlke of Stanford University for information on characid phylogeny and for the use of his cleared and stained characids for comparative purposes.

Habits of the Gasteropelecinae

In general the gasteropelecins live near surface waters where they feed on insects that alight or fall on the water. Their heavy upturned jaws with large sharp teeth serve ably in grasping and cutting insects. *Gasteropelecus sternicla, Carnegiella strigata,* and *Carnegiella vesca* normally inhabit the surface waters in aquaria and when driven downward by a net usually return to the surface immediately upon removal of the net.

Eigenmann and Breder have given the most reliable field observations on

gasteropelecin flight. Eigenmann (1912, p. 47) states the following: "The latter [flying fishes] would dart up in front of us, cut through the water, leaving the breast or tail in the water and beating the water with their pectorals. One of the flying fishes would cut through the water for forty feet or more and then leave the water entirely for five or ten feet. At the end of its flight it would fall sidewise into the water." Eigenmann further states, "when the momentum was gone, the disc-like shape could easily be made out." Although Eigenmann did not capture any gasteropelecins at this locality there seems to be little doubt that he saw some kind of gasteropelecin in flight. A preliminary "taxi" may be the usual beginning of a flight; however, Breder (1927, p. 126), basing his observations on *Gasteropelecus maculatus* in Panama, states, "the only difference that seems to exist between their [generalized characids'] leaps and the 'flight' of the present species is that the former fall back nearly where they started describing a somewhat 'hair-pin' parabolic arc, whereas *Thoracocharax* [*Thoracocharax maculatus=Gasteropelecus maculatus*] by virtue of its wing like pectorals has a more flattened trajectory. Occasionally they indulge in a more sustained 'flight', but that is not often." This statement indicates that a preliminary taxi in at least *Gasteropelecus maculatus* is not necessary. This is also true for *Gasteropelecus sternicla, Carnegiella strigata,* and *Carnegiella vesca,* since I have seen all three of these species in aquaria leave the water without a preliminary taxi. Breder apparently could not decide whether these fish actually fly or not, for in 1927 he stated: "This flight seems to be the simple trajectory of a characid leap flattened by the presence of these pectorals..., although at times they seem to be able to sustain themselves for some little distance, and there may be some fin movement as Ridewood (1913) suggests for *Gastropelecus* [sic.]."

Fraser-Brunner (1950b) assumed that these fish actually do not fly, for he stated: "On looking at the fish it does not need a great knowledge of aerodynamics to see that the likelihood of its becoming airborne is very small." Instead he stated that the fish beats the water with its pectorals and skitters over the surface with its tail in the water; however, he went on to say that the pectorals might supply some lift if the fish is actually airborne but that the flight would be very short. Hoedeman (1952) apparently followed Fraser-Brunner in the opinion that these fish do not fly. However, both *Gasteropelecus* and *Carnegiella* readily jump out of aquaria and continue through the air for surprising distances without a preliminary taxi or skittering. I suspect that they also do this in nature when escaping from enemies. Myers (1950) made a few logical suggestions as to how flight is accomplished. He believed that the pectoral fins may produce a "buzzing" sound and are moved in flight somewhat like the movement of hummingbirds' wings.

On February 21, 1950, I was fortunate in hearing the "buzz" from the pectoral fins of *Carnegiella vesca.* Five specimens had been transferred from an aquarium to a half-full, wide-mouth, gallon jar. As I bent over to observe these fish from above, one of them leaped from the water and hit my wrist at a point about two and one-half feet directly above the water surface. I distinctly heard a faint buzz as the fish passed a few inches from my ear. Undoubtedly the pectoral fins were in motion and probably aided the fish in its flight, although much of its initial velocity was unquestionably gained by the leap from the water. A two and one-half foot vertical jump is very high for an inch and one-quarter long fish, and since the fish hit my wrist with such force that it would have gone higher, I can only conclude that the pectorals materially aided the fish in its leap. Exactly how flight is accomplished and how much true flight occurs with the aid of the pectoral fins is still unknown. The use of high speed photography might aid in determining these matters. Although it seems that the

fish use their pectorals as an aid in maintaining velocity in the air they undoubtedly do not possess true self-directional flight as do insects and birds.

Osteology of *Carnegiella vesca* Fraser-Brunner

Cranium (Figs. 2-5, 7-8, 10): The median ethmoid or mesethmoid (eth) is the most anterior bone of the cranium. Posteriorly the ethmoid passes back as a thin blade under the two frontals (f) to contact part of the posterior dorsal surface of the lateral ethmoids or prefrontals (le). The thicker anterior end of the ethmoid has lateral slitlike fossae for the reception of the premaxillaries (pmx). Ventrally the ethmoid bears a process which contacts the prevomer or vomer (pvo) on a broad suture.

The toothless prevomer (pvo), also a median bone, is broad anteriorly where it contacts the ethmoid; posteriorly it tapers to a narrow blunt end which is inserted into a fossa on the anterior end of the parasphenoid (ps). The broad anterior portion of the prevomer is thick and pierced by a few small foramina. The posterior portion is dorsoventrally thin.

Below the anterior end of the frontals (f) and behind the prevomer (pvo) are the paired lateral ethmoids (le). These bones form the upper anterior wall of the orbit. The lateral ethmoid extends inward as a plate from the lateral edge of the frontal, not quite meeting its counterpart of the other side at the median axis of the cranium. The upper median anterior portion of the lateral ethmoid is a blade that extends forward and downward toward the prevomer and then back toward the lower median anterior portion of the lateral ethmoid. In large specimens this process sometimes fuses with the ventral median portion of the lateral ethmoid. Between the blade and the main body of this bone is an opening for the passage of the olfactory nerve. The median ventral portion of the lateral ethmoid has a surface which bears a broad ligament that attaches to the dorsal anterior surface of the mesopterygoid (mspt).

The ethmoid cartilage lies between the blades of the lateral ethmoid (le) and between these two blades and the ethmoid bone (eth). It extends down to contact the dorsal surface of the part of the median, thin portion of the prevomer (pvo), that lies between the lateral ethmoid blades. It also contacts the lateral ethmoid blades in this region.

Most of the anterior dorsal surface of the cranium is composed of the two frontals (f) which form the roof of the orbit. These bones unite along the median axis of the cranium in a slightly irregular suture. Either the right or left frontal will slightly overlie its fellow, especially along the posterior portion of this suture. Both frontals are elevated along this suture forming a broad median ridge. The frontal bears a rather deep longitudinal depression that extends from the region over the lateral ethmoids (le) back onto the parietal (par). Extending longitudinally in this depression is a steep ridge that rises to a height equal with that of the median elevation of the frontals. This ridge is pierced by a large foramen at the deepest part of the depression. Medial and anterior to this foramen several sensory canals perforate the frontal. These canals unite within the frontal to form a single canal which opens on the ventral side of this bone below the large foramen in the ridge. The posterior ventral side of the frontal has a thin blade extending downward that overlaps the upper anterior portions of the sphenotic (sp) and pleurosphenoid or alisphenoid (pls). The frontals are fused to each other by a small transverse bar on their inferior surface above the pleurosphenoids.

The paired parietals (par) meet along the midline of the cranium and are bounded by the frontals (f), sphenotics (sp), pterotics (ptr), supratemporals or tabulars (stm), epiotics (ep), and supraoccipital (soc). The

posterior border of the parietal bears a slotlike fossa for the insert of the first row of scales (scs). Just anterior to this fossa the perie contains a sensory canal. This canal begins as an exterior opening in supratemporal, passes through the supratemporal and into the parietal, proceeds up the posterior part of the parietal to meet its counterpart the other side. Internally the top of the large anterior vertical se circular canal passes along the ventral side of the parietal. Externa the parietal shows the contour of this canal.

Ordinarily the supratemporals or tabulars (stm) are small bones conta ing sensory canals loosely applied to the cranium; however, in *Carnegie vesca* they are small, thick bones forming an integral part of the crani In addition the supratemporal has become firmly involved in the support the pectoral girdle, the posterior portion of the supratemporal fitt snugly into a shallow depression on the anterior lateral surface of t fused posttemporal and supracleithrum (ptm+scl). For further discuss of the relationships of the supracleithrum and the posttemporal see t section on the discussion of the secondary portion of the pectoral girdl Medial to the supratemporal is the highly reduced posttemporal fossa (p with its foramen. In most characids this fossa covers an extensive port of the posterior surface of the cranium but in *C. vesca* the enlarg epiotic (ep) has forced it to a small area under the supratemporal.

The supraoccipital (soc) rests on the exoccipitals (ex) and epiot (ep). Anteriorly it passes under the parietals (par) for a short distan and posteriorly it bears a median crest for the attachment of trunk musc and ligaments to the intermuscular bones.

The exoccipitals (ex) are large paired bones covering much of the b of the cranium and part of its floor. The upper border of the exoccipi is bounded by the supraoccipital (soc) and the epiotic (ep). The basi cipital (boc) is applied to the ventral border of this bone and anterio and ventrolaterally it meets the prootic (pro). The region around t foramen magnum (fm) is somewhat modified. The exoccipitals have gr backward around the foramen magnum and the two foramina (fs) for t scaphia (scp) to a greater degree than in other characids examined. Th three foramina are still present but are included within the cranium, an new larger foramen has been formed somewhat posterior to them. The posterior extensions of the exoccipitals cover most of each scaphium (s of the Weberian apparatus. Within the cranium each exoccipital has a sh of thin bone that extends medially to meet its counterpart at the midli These serve as a roof over the cavum sinus imparis (er) (Figs. 5, 10). spinal cord enters the cranium just above this shelf. Both outside within the cranium the exoccipital serves as the upper covering of the v large lagenar chamber. Just above the upper posterior border of th chamber the exoccipital is pierced by a foramen. Somewhat higher than t foramen and anterior to the lagenar chamber is another foramen also lead into the cranial cavity. This foramen lies at the top of a deep fossa s in the lateral view of the cranium (Fig. 3). This foramen cannot be s in the ventral view because it is covered by the lagenar chamber.

The opisthotic (opi) is a small tabular bone firmly applied to the ex cipital (ex) just behind and below its junction with the pterotic (ptr) epiotic (ep). The basioccipital (boc) is applied to the ventral side the exoccipitals. Anteriorly it meets the prootics (pro) and its lo median anterior portion is covered by part of the parasphenoid (psp). posterior face of the basioccipital is shaped like a centrum and serves an articulation surface for the first vertebra. The lower coverings of lagenar chambers are formed by the basioccipital and much of the elong saccular cavity is embedded in this bone. In Fig. 10 the saccular cav of the left side is shown in longitudinal section, the left half of it h ing been cut away. The basioccipital also serves as most of the floor

the cavum sinus imparis.

Each epiotic (ep) is surrounded by the parietal (par), supraoccipital (so), exoccipital (ex), opisthotic (opi), and pterotic (ptr). Most of the epiotic's upper anterior borders lie under the parietals. The upper posterior portion of the epiotic bears a prominence to which the epiotic lamella (el) is attached by a ligament. The contour of the epiotic follows the shape of the posterior vertical semicircular canal which fills much of this bone. The ventral portion of this semicircular canal is contained in the exoccipital.

The dorsal edge of each pterotic (ptr) lies under each parietal (par). Anteriorly the pterotic meets the sphenotic (sp); ventrally the prootic (pro); and posteriorly the epiotic (ep), supratemporal (stm), and exoccipital (ex). The ventral anterior end of the pterotic bears a part of the lateral temporal groove which serves as the articular surface for the hyomandibular (hy). There is no sensory canal in the pterotic. The lateral-most border of the pterotic has a ridgelike prominence which forms a small fossa beneath it. The posterior lateral portion of this bone projects downward to form a thin strong prominence. Internally the pterotics serve as the bony support for the horizontal semicircular canal.

The sphenotics (sp) are thick bones situated under the lateral region of the frontals (f) and parietals (par) and form part of the posterior wall of the orbit. Laterally the sphenotic bears a short prominence. On the ventral surface of the sphenotic along its suture with the prootic (pro) is the continuation of the lateral temporal fossa from the pterotic (ptr). Lateral to this fossa is another deeper fossa which also continues onto the anterior part of the pterotic. The internal posterior portion of the sphenotic has a fossa for the reception of the anterior portion of the anterior vertical semicircular canal as it passes down from the parietal. Anteromedially the sphenotic meets the pleurosphenoid (pls). In the posterior wall of the orbit is a foramen having for its border the sphenotic, prootic, and pleurosphenoid.

The floor of the brain case is largely formed by the paired prootics (pro). The prootic is bordered by the pleurosphenoid (pls), sphenotic (sp), pterotic (ptr), exoccipital (ex), basioccipital (boc), and the parasphenoid (psp). Anteriorly it has a thin sheet of bone extending upward that overlaps part of the anterior surface of the pleurosphenoid (pls). The median anterior portion of the prootic forms the roof of the myodome. The floor of the myodome is closed and formed by the parasphenoid. The posterior region of each prootic bears a large auditory foramen (af) through which part of the lapillus (lap) can be seen. The rest of the lapillus lies in a depression in the floor of the prootic. Along the median border of the auditory foramen is a large groove which passes anteriorly into a canal. This canal passes in the prootic to another foramen that leads into the brain cavity in the anterior region of the prootic. Medial and somewhat anterior to this foramen is another foramen leading into the cranial cavity. In one specimen this small foramen was found to lie between the prootic and parasphenoid. The pleurosphenoids or alisphenoids (pls) are thin flat bones serving as part of the posterior wall of the orbit.

The orbitosphenoid (osp) is a Y- or V-shaped bone; its two dorsal arms usually lie against small prominences of the frontals (f) which are directly below the two foramina that open on the ventral side of the frontals. Occasionally the uppermost parts of the orbitosphenoid are forked and meet two prominences under each frontal. The lowermost portion of the orbitosphenoid has an arm of bone projecting backward and tapering to a fine point. The ventral side of the orbitosphenoid is attached to the parasphenoid (psp) by a strong ligament. The orbitosphenoid serves as a median bony support for the large eyes. There is no rhinosphenoid.

The parasphenoid (psp) extends from the prevomer (pvo) to near the

lagenar portion of the basioccipital (boc). Below the anterior region of the prootics (pro) the parasphenoid is widened to form the floor of the myodome. This bone serves as a stout bracing for the ethmoid region against the base of the cranium.

In general the crania of other members of the subfamily Gasteropelecinae examined agree with the description above. However, some notable differences occur. All the species of *Carnegiella* are without a lateral sensory canal in the pterotic. Members of both the other genera of the Gasteropelecinae have this canal. Likewise in the species of *Carnegiella* the sensory canal of the supratemporal does not divide and proceed anteriorly into the pterotic and posteriorly into the posttemporal-plus-supracleithrum as it does in other gasteropelecin genera examined. Instead it comes to the surface of the supratemporal. Here the sensory canals pass forward over the external surface of the pterotic and backward over the surface of the posttemporal-plus-supracleithrum to enter that bone in its supracleithral component.

The epiotic lamella is the subject of interesting variation among the genera and species of the Gasteropelecinae. In *Carnegiella vesca* and *strigata* it is large and attached to the epiotic by a ligament. In *myersi* it is about half the size of that in *vesca* and *strigata* and is fused to the epiotic. In *Gasteropelecus maculatus* it is large and fused to the epiotic in *sternicla* it is fused but very small. In *Thoracocharax stellatus* the condition is the same as in *G. maculatus*, while *T. securis* has a condition similar to that of *G. sternicla*.

Otoliths (Fig. 6): The otoliths are typical of the Characidae as described by Adams (1940). The most anterior otolith, the lapillus (lap) lies in the membranous sac that lies in a depression on the dorsal lateral surface of the prootic (pro)(Fig. 4). The sagitta lies in the membranous sacculus which fills the saccular cavity of the basioccipital (boc) and extends forward onto the posterior medial part of the prootic. The anterior portion of the sagitta is thick with four ridges; the posterior portion is thin and bladelike. The large heavy asteriscus (ast) lies in the membranous lagenar sac which fills the lagenar chamber of the exoccipital (ex) and basioccipital (Fig. 10). The flattened surface of the asteriscus is vertical and at about a 45° angle to the sagittal plane of the body.

Orbital Bones (Fig. 7): The second and third orbital bones (orb) are present. The adnasal (ad) forms a thin bony covering for the lower portion of the nasal capsule. It is not fused with a bony sensory tube for the orbital branch of the sensory canal system. Indeed this bony tube is absent in the orbital region except in the region normally possessing the fifth orbital bone. In a 19-millimeter specimen, the bony sensory tube (st5) has its lateral surface open; however, in larger fish this tube becomes closed usually leaving a few small fenestrae.

Carnegiella marthae and *schereri* have the same arrangement of orbitals as *vesca* except that the second and third orbitals are also absent. *Carnegiella strigata* has the same orbital arrangement as *vesca*. *Carnegiella myersi* retains the fifth orbital bone and otherwise is like *vesca*.

Gasteropelecus maculatus has the first, second, third, fifth, and usually the sixth (dermosphenotic) orbitals; *sternicla* has the same condition except that the sixth is usually absent. In one specimen of *sternicla* the second orbital was fused with the third. In these two species the second and the fifth are fused with bony canals for the sensory system. Both species of *Thoracocharax* have the same orbital bones as *Gasteropelecus* except that the sixth is absent. In both *Gasteropelecus* and *Thoracocharax* the fourth ortital is occasionally present. When it is absent the fifth orbital bone extends downward to contact the third orbital

Nasal Bone (Figs. 2, 4, 7): The nasals (n) are short, small, tubular bones serving as a bony encasement for part of the sensory canal system

.h nasal is superior to the nasal organ and has its posterior and medial
ers against the anterior portion of the frontal (f).

ercular Apparatus (Figs. 7-8): The opercle (op) is a large, smooth-
aced bone in the lateral part of the face. The subopercle (sop) is a
g, thin bone applied to the long lower median surface of the opercle.
erior to the lower portion of the opercle is the preopercle (pop).
s bone fits along the ventral lateral edge of the hyomandibular (hy).
t most forward portion fits into a groove on the median inferior side of
quadrate (qu). The lateral side of the preopercle has a groove through
ch run nerves of the sensory canal system. These enter the preopercle
m the region of the pterotic (ptr). Anterior to the subopercle the in-
opercle (iop) is applied to the median lower surface of the preopercle.

All gasteropelecins have an opercular apparatus essentially similar to
t of *Carnegiella vesca*. However, in all members of *Gasteropelecus* and
racocharax examined the sensory canal enters the top end of the pre-
rcle and passes through a sensory tube attached to this bone into the
p groove along the preopercle's lateral border.

Upper Jaw (Figs. 2, 4, 7): The premaxillary (pmx) is a stout bone bear-
a single row of eight to ten teeth. The anterior four or five teeth
large and tridentate. The rest become progressively smaller and are
equently simple, sharp, and conic. Medial to each tooth is a small re-
acement tooth. The median side of the premaxillary fits into a groove on
e lateral side of the ethmoid (eth) and its posterior portion fits over
e anterior edge of the frontal (f).

The slender upper arm of the maxillary (mx) rests against the posterior
de of the lower portion of the premaxillary (pmx). Below this slender
m, the maxillary is a strong flattened bone bearing a single tooth at the
per portion of its anterior edge.

Lower Jaw (Figs. 7-8): The strong lower jaw consists largely of the
oth bearing dentary (den) and the articular (art), the splenial (spl) and
gular (an) being very small bones. The dentary usually has about 12 or
teeth in a single row. The anterior four to six of these are large and
identate. The rest are sharp, small, and conic. Each replacement tooth
r the large teeth rests in an open cavity medial to its large tooth in the
ntary. The replacement tooth of each of the small teeth rests in the
esh medial to these teeth. The symphysis of each maxillary (mx) has
rooves and ridges that form a hinge mechanism allowing slight lateral ex-
nsion of the jaws. The lateral surface of the dentary has a sensory
nal, a continuation of the sensory canal system from the preopercle (pop).

The articular (art) fits against the inside posterior portion of the
ntary (den). Posteriorly the articular has a socket for the condular
rface of the quadrate (qu). Below this socket is the tabular angular
ea. Its dorsal surface butts against the articular and its inner ventral
rface rests against the dentary. Meckel's cartilage extends in a groove-
ike fossa along the medial side of the dentary and articular. Above the
osterior portion of Meckel's cartilage and lying against the articular is
ne small splenial (spl).

Mandibular Arch (Figs. 7-9): The hyomandibular (hy) forms the main bony
uspensory mechanism for the opercular apparatus, branchial arches, hyoid
rch, and mandibular arch. Its posterior end is slab-shaped, its dorsal
urface fits into the lateral temporal fossa of the cranium. The upper
osterior border of the hyomandibular bears a condyle for the articulation
f the opercle (op). The long arm of the hyomandibular passes along the
pper inner border of the preopercle (pop). The anterior end connects by
artilage to the elongate symplectic (sym) and the interhyal (ihy) of the
yoid arch. The anterior end of the sympletic lies in a fossa on the inner
ide of the quadrate (qu). The quadrate lies over the dorsal anterior edge
f the preopercle. Its anterior end bears a condyle for the reception of

the articular (art) of the lower jaw.

Palatine Arch (Figs. 7-8): Above the quadrate (qu), sympletic (sym), and anterior portion of the hyomandibular (hy) is the palatine arch. The four bones of the palatine arch suspend the anterior region of the mandibular arch from the cranium. Above the junction of the sympletic and hyomandibular is the metapterygoid (mtpt). It attaches to both these bones and the posterior portion of the quadrate by cartilage. Above the upper anterior end of the metapterygoid is the large flat mesopterygoid (mspt). The mesopterygoid forms the lower anterior wall of the orbit and the metapterygoid the lower medial wall. The upper face of the mesopterygoid is attached to the lower edge of the lateral ethmoid (le) by a broad ligament. Anterior and dorsal to the pterygoid (pt) and mesopterygoid is the toothless palatine (pal) that bears a knob articulating against the upper arm of the maxillary (mx).

Hyoid Arch (Figs. 7-9): A small cylindrical interhyal (ihy) attaches the main portion of the lower hyoid arch to the distal end of the hyomandibular (hy). Below the interhyal is the triangular flattened epihyal (ehy). The epihyal serves as an attachment for the elongated fourth branchiostegal ray (brg). The ceratohyal (chy) is fastened to the anterior edge of the epihyal by a firm suture. The lower edge of the large ceratohyal serves as an attachment for the short first and second, and elongate third, branchiostegal rays. The ceratohyal has a sensory canal along its dorsal lateral edge and attached to its anterior edge are the dorsal (dhhy) and ventral (vhhy) hypohyals. A large foramen occurs between the two hypohyals and the ceratohyal. Above the median edge of the dorsal hypohyal of each side is the median toothless basihyal (bhy). Below the median edges of the hypohyals is the median urohyal (uhy). The urohyal is short and stubby, not elongate as is usual in most characids and other teleost fishes.

Branchial Arches (Fig. 9): The branchial apparatus is suspended from the base of the cranium along the lateral edge of the parasphenoid (psp) by suspensory pharyngeals or modified pharyngobranchials (sph). The first three arches are relatively unmodified and are all alike. Each arch has an epibranchial (ebr) below its suspensory pharyngeal. These two constitute the upper limb of the arch. The lower limb consists of an elongate ceratobranchial (cbr) and a short hypobranchial (hbr). The hypobranchials of each side attach by cartilage to median basibranchials (bbr).

The first basibranchial (bbr) is largely cartilage and has only its anterior end ossified. It attaches to the posterior end of the basihyal (bhy) and the anterior end of the second basibranchial. The second and third basibranchials are elongate bony structures joined to each other and to the first. Behind the third basibranchial is a mass of cartilage that in some specimens has a thin layer of bone on its dorsal surface.

The various parts of the fourth and fifth arch are modified. Both arches lack a hypobranchial. The ceratobranchial (cbr) of the fourth arch is normal but that of the fifth arch is expanded medially into a tooth-bearing plate called the lower pharyngeal (lph). The upper portions of the fourth and fifth epibranchials (ebr) have fused solidly to one bone; their lower portions diverge but are joined by a thin shelf of bone. The two tooth-bearing upper pharyngeals (uphs) attached to this bone are probably modified fourth and fifth pharyngobranchials.

The first branchial arch has four short gillrakers along its upper limb and seven or eight long gillrakers along its lower limb. The gillrakers are slightly ossified at their bases and only rarely ossified their entire length. The gillrakers are not figured.

Weberian Apparatus (Fig. 10): Although Watson (1939) has shown the homologies of the parts of the Weberian apparatus in Cyprinidae by use of developmental anatomy, this has not been done in Characidae. There are consistent differences in the anatomy of the Weberian apparatus in Cyprinidae

d Characidae; however, similar parts in the two families probably have ilar origins. Terminology used here is based on Watson (1939) and on (1948, 1949).

uch claustrum (clu) is a small element on the inner posterior border of c scaphium (scp) and in some specimens it is scarcely ossified, being ely represented by cartilage. The scaphium is a large, platelike bone, sconcave surface facing anteromedially, its convex surface facing posrlaterally. The innermost border of the bone bears dorsal and ventral culating processes. The dorsal process rests against the neural cle (npd) and the ventral process fits into a pit on the dorsolateral face of the first centrum (c). The posterior surface of the scaphium a low prominence for the attachment of the interosseous ligament. The rcalarium (int) is a T-shaped bone, the long arm of the T articulating nst the neural pedicle. The anterior arm serves as an attachment for interosseous ligament while the posterior arm is a process resting aist the centrum of the second vertebra. The interosseus ligament passes kward to attach to the most anterior portion of the tripus (tr). The us bears a median articulating process that runs vertically along the erior part of the centrum of the third vertebra. Laterally the tripus sists of a large heavy arm. Fused to the posterior end of this arm is delicate transformator process (tfr) which extends medially under the rth vertebra and there attaches to the air bladder.

The centrum (c) of the first vertebra has no appendages. It consists of a disc with two dorsal cuplike depressions for the reception of the tral articular processes of the scaphia (scp). The second vertebra has rocess similar to that which Watson (1939) found to be a dorsal rib (dr) the cyprinid *Carassius auratus*. Nelson (1949) found a pleural rib (pr) ed to this process in the characid *Rhaphiodon vulpinus*. In *Carnegiella* ca the dorsal rib is a long, slightly curved process. Although a pleua rib may be attached to the dorsal rib it cannot be determined from its phology. Proper designation of this process must await developmental dy of the Weberian apparatus in characid fishes. Above and fused with centrum (c) of the third vertebra are the neural pedicles (npd). eral to each neural pedicle and the centrum is the horizontal plate l). In *Rhaphiodon vulpinus*, Nelson (1949) found this plate to be coed of a "nonmovable articulation of the 'transverse process' of the sec- and third vertebrae plus a transverse process of the third neural icle."[1] In the present form the horizontal plate is formed only by the ansverse process" of the third vertebra and a transverse process of the rd neural pedicle. Above the neural pedicles and scaphia is the neural plex (ncom). The fourth vertebra has a neural spine (nsp) which remains ided (i.e., the elements on each side do not fuse to a single spine but main separate) and the neural arch is not closed. The fourth vertebra of *rnegiella vesca* bears a lateral process. The equivalent process was lled the "transverse process" in *Rhaphiodon vulpinus* by Nelson (1949). wever, since in *Carnegiella vesca* this process is weakly fused to the centum as are the parapophyses (pap) of the rest of the precaudal vertebrae, appears that this process may be a parapophysis. Fused to this process the remnant of a pleural rib. The pleural rib portion is sometimes more atelike than in the specimen illustrated. The shape of this entire proc- s is quite variable. The os suspensorium (oss) originates on the anteri- median surface of the parapophysis and fused pleural rib. It extends as thin plate inward and forward under the third vertebra where it does not ite meet its counterpart from the other side. The fifth vertebra is undified.

[1] Nelson (1949) used the term "transverse process" to designate the ructure that may be a dorsal rib. In the same paper he used transverse ocess for a lateral process of the neural arch pedicle.

Precaudal Vertebrae (Fig. 11): The precaudal vertebrae are those with out a haemal spine. There are 12 precaudal vertebrae, the first four bein modified to form the Weberian apparatus described above. The fifth throug the ninth vertebrae are much alike in their morphology. Each has a neura spine (nsp), a neural arch (na), two neural prezygapophyses (nprz), tw neural postzygapophyses (npoz), a centrum (c), two parapophyses (pap), an a pleural rib (pr). The parapophyses are weakly fused to their centra The pleural rib articulates to the lateral edge of each parapophysis.

The following differences occur in the tenth, eleventh, and twelfth ver tebrae. The tenth vertebra has the parapophysis (pap) solidly fused to th lower anterior portion of the centrum (c). The eleventh vertebra, the las to bear a rib, has a haemal arch (ha) but no haemal spine. The rib of th vertebra articulates on the lateral ventral portion of the haemal arch The eleventh vertebra also has haemal postzygapophyses (hpoz). The twelft vertebra is the same as the eleventh except that there are no ribs.

Caudal Vertebrae (Fig. 12): There are usually 20 caudal vertebrae. Th thirteenth through the twenty-sixth vertebrae are essentially all alike The sixteenth and seventeenth (Fig. 12) are typical. Dorsally each verteb has a neural spine (nsp), a neural arch (na), two neural prezygapophyse (nprz), and two neural postzygapophyses (npoz). Below the centrum (c) the haemal arch (ha) and haemal spine (hsp). There are two haemal post zygapophyses (hpoz) but no haemal prezygapophyses. The twenty-sevent through thirty-first vertebrae have the haemal postzygapophyses fused t the haemal arch.

The last four caudal vertebrae (29 through 32) support the caudal f rays. The twenty-ninth through thirty-first vertebrae have elongate neural (nsp) and haemal (hsp) spines that articulate with the dermal f rays of the caudal fin. The neural spines are not modified except l elongation; however, the haemal spines are laterally flattened. Th thirty-second vertebra or urostylar segment has a urostyle (ust) extendi dorsally and posteriorly above the free hypural bones. There are s hypurals (hyp), the lowermost being fused to the urostylar vertebra whi the rest are autogenous. Above the urostyle are two free epurals (epu One pair of uroneurals (un) occurs on the lateral posterior surface of t urostyle. Their dorsoposterior ends are fused as in a neural spine.

Intermuscular Bones (Fig. 12): Three kinds of intermuscular bones occ in *Carnegiella vesca*. The terminology used here follows Chapman (1944).

The dorsal myorhabdoi (myr) are slender unforked bones projecting bac ward and downward in the myocomma from each neural spine (nsp). There one on each side for the first to twenty-fifth or twenty-seventh segment Occasionally one or two ventral myorhabdoi occur in the twenty-sixth twenty-seventh segments.

The epineurals (epn), which lie in the myocomma, project back and upwa from the neural arch (na) and spine (nsp). There are usually 29. T first eight are unforked or only slightly forked. The next eleven a deeply forked anteriorly. The last ten or eleven are unforked.

There are usually 20 epipleurals (epp). They occur in the myocomma the eleventh to the thirty-first vertebra. The first is sometimes forke the second through ninth are forked, and the rest unforked.

Dorsal Fin (Fig. 14): The terminology for the median fins follows Eat (1945). The dorsal fin begins between the sixteenth to eighteenth vertel and ends anterior to the twentieth to twenty-second vertebra. Nine proxir radials (pra) or pterygiophores (interneurals) occur between the neur spines (nsp). A median keel projects forward from the first proximal rac al. Above the proximal radials and between the right and left bases of t dorsal fin rays (dfr) or lepidotrichia are the distal radials (dra) pterygiophores. Each distal radial is almost split in two by a median f sure. There are nine fin rays, the last being divided to its base. Ea

a consists of right and left halves, each half being segmented into sev- bony parts.

orny actinotrichia are present at the distal end of each ray. These between the halves of the fin rays and project beyond them slightly. e are actinotrichia in all the fin rays of *Carnegiella vesca*.

nal Fin (Fig. 15): The anal fin is similar to the dorsal fin in struc-. Proximal radials (pra) or pterygiophores (interhaemals) project up- between the thirteenth to the twenty-fifth or twenty-sixth haemal es (hsp). The anterior four to five proximal radials have small thin an keels. The distal radials (dra), as in the dorsal fin, are almost ded in two by a median fissure. There are 26 to 30 fin rays (afr), the st three being undivided and the last divided to its base. In males l bony hooks are present on the sixth to usually the sixteenth anal fin s. These hooks or short spines occur on the posterior lateral edge of anal fin rays (Fig. 15A).

Supraneurals (Fig. 12): Anterior to the dorsal fin is a series of eight ten median bones called supraneurals (supn). They are stout tubular es each slightly anterior to the tip of the neural spine below.

Pectoral Girdle (Figs. 16-17): The primary portion of the pectoral idle of *Gasteropelecus maculatus* has been described in detail by Starks 30). The primary pectoral girdle of *Carnegiella vesca* differs in essential way. The cleithrum (cl) is elongate, its anterior portion ng outward under the head forming a floor under the hyobranchial appara-. The inferior portion of the lateral wing of the cleithrum is reduced a low ridge while the dorsal portion of the cleithrum is thickened to m a strong support for the mesocoracoid (mec).

The mesocoracoid (mec) is a strong bar extending from the upper median tion of the cleithrum (cl) downward and inward, being supported from be- by a process of the scapula (sca) and coracoid (cor).

The scapula (sca) lies below the mesocoracoid (mec) and the posterior tion of the cleithrum (cl). Ventrally and medially it contacts the acoid (cor). Dorsally the scapular foramen is completely surrounded by scapula, although ventrally the cleithrum also takes part in its border ce the latter overlaps the scapula. The lateral edge of the scapula has articular surface for the first pectoral fin ray and the radials (rad).

The coracoid (cor) unites with its counterpart from the opposite side l extends downward to form a single, highly enlarged, fan-shaped bone. s expanded surface is of radiating corrugations for added strength.

The radials or actinosts (rad) are three in number. They are closely tted but not fused, forming a unitary structure. In specimens of *Gastero-lecus* and *Thoracocharax* examined there were four of these closely fitting nes. The stained specimens of *Carnegiella myersi* had all the radials sed to form a single solid structure.

The first pectoral fin ray (pfr) is enlarged and unbranched. The prox-al end of the dorsal half of the first ray articulates with the scapula ca). The proximal end of the ventral half has a rounded surface for the sertion of a muscle. The ventral half is the thickest, forming a strong pport for the entire elongate ray. The dorsal and ventral halves are rmly applied to one another. In old specimens they may be fused partial- as they could not be separated without breakage. The second ray fits ainst and in a posterior fossa of the first. The remaining nine rays ar-culate to the radials (rad) and have small bones (ossified distal cartil-es of the radials) between their proximal halves. There are almost al-ys eleven pectoral fin rays.

The secondary portion of the pectoral girdle is highly modified. The osition and function of the supratemporal (stm) has been described under e cranium since it is an integral part of the cranium. The posttemporal d supracleithrum (ptm+scl) have united to form a single bone (Figs. 2, 7).

In *Thoracocharax* the separate arms of the posttemporal can be clearly dis tinguished, and the posttemporal and supracleithrum, although fused, loo similar to those in *Triportheus* in which they are closely appressed but no fused. The upper anterior portion of the posttemporal-plus-supracleithru in *Carnegiella vesca, strigata,* and *myersi* is firmly and almost immovabl fastened to the cranium by ligaments; the lower median portion is firml applied to the upper outer portion of the cleithrum. The supratempora canal passes through the posttemporal-plus-supracleithrum to the latera line. There is usually at least one scale in the lateral line. There ar no bones representing postcleithra.

Pelvic girdle (Fig. 18): The pelvic girdle is highly reduced in size It consists of a small flattened pelvic bone and five pelvic fin ray (pvfr). The pelvic bones (pb) of each side are closely approximated an have their flattened sides facing each other.

Functional Modifications of the Gasteropelecinae

Functional modifications in the Gasteropelecinae are related to th feeding and flight habits. The most highly modified portions in thes fishes are the head and pectoral girdle.

The head is modified for grasping organisms above it at the surface o the water. The jaws are almost vertical and the heavy mandible snaps back ward thrusting its force almost directly against the axis of the cranium There are three mechanisms which receive the thrust of the lower jaw: th palatine arch, the frontals, and the parasphenoid. In the first of thes the force is transferred from the upper jaw to the palatine and then to th facial region through the pterygoids. The frontals and parasphenoid re ceive much of the thrust, transferring the pressure to the cranium in gen eral. The frontals form a corrugated unit and with the added strength o their ridges ably withstand the pressure applied by the mandible through th premaxillary and ethmoid. Similarly the parasphenoid has added strength being T-shaped in cross section for much of its length. Since the mandibu lar thrust is applied almost directly against the axis of the cranium in stead of from below upward, the need for the arch below the frontals forme by the rhinosphenoid, orbitosphenoid, and pleurosphenoid is reduced. I the Gasteropelecinae the frontals have taken over the function of th sphenoid arch. The rhinosphenoid is absent, the orbitosphenoid is reduce to an element that supports the eyes, and the pleurosphenoid serves as small arch partially uniting the frontals with the rest of the cranium

In correlation with the nearly vertical angle of the mouth and the an terior expansion of the coracoids, the entire lower portion of the face i elongated and thrust forward. The branchiostegal rays, lower portion o the opercle, subopercle, preopercle, and hyomandibular are exceptionall long. Correspondingly, the lower portion of the branchial basket is some what elongated.

In all members of the Gasteropelecinae the semicircular canals, otoliths and structures associated with balance, hearing, and pressure perceptio are larger proportionately than in other characids examined. Thus, th epiotic (enclosing the posterior vertical semicircular canal) has enlarge at the expense of the posttemporal fossa, reducing it to a slight depres sion and foramen under the supratemporal. Balance and detection of pres sure are undoubtedly very important in these fishes.

The scaphia of the Weberian apparatus have been largely included withi the protection of the cranium. The intermuscular bones behind the head ar better developed than in other characids examined. In *Gasteropelecus* an *Thoracocharax* there are sometimes three or four ventral myorhabdoi belo the last three or four epipleurals.

The primary portion of the pectoral girdle is constructed to allow extremely rapid vibration of the fin. The large, fused, fan-shaped coracoids serve as attachment for muscles that depress the fin and move it outward and then backward. Muscle masses originating on the dorsal surface of the coracoid, passing backward under the mesocoracoid, and inserting on the dorsal surface of the fin rays elevate the fin. Muscle masses originating on the median side of the cleithrum and inserting on the dorsal base of the fin rays serve the same purpose. The general arrangement of muscles of the pectoral girdle suggest that the fin may be used to produce movement comparable to the rapid wing-beats of some birds and insects. It should be pointed out that the shape of the pectoral fin is like an airfoil and that it is cambered. The leading edge of the pectoral fin is thick, consisting of the heavy first ray, while the trailing edge is very thin, being supported by the finely divided ends of the fin rays. With these facts and considering that the pectoral fin can be heard when the fish is in the air it can only be concluded that these fish must use the pectoral fin for partial support and maintenance of velocity through the air. The cleithrum is elongate and its ventral portion passes over the anterior portion of the coracoid serving both as muscle attachment and as a floor for the gill cavity.

The secondary portion of the pectoral girdle is likewise modified, its main function being to attach rigidly the primary portion of the girdle to the cranium. Postcleithra are absent. The posttemporal and supracleithrum are present and solidly fused to form a single bone. From its posttemporal portion the posttemporal-plus-supracleithrum is firmly attached to the cranium by a broad ligament to the pterotic. The lower medial side of the posttemporal-plus-supracleithrum has a strong columnar ligament (the "transcapular" ligament) attaching it to the anterior side of the scapular capsule (basioccipital portion). The supratemporal has its anterior end firmly sutured to the pterotic and parietal. The posttemporal-plus-supracleithrum passes between the posterior portion of the supratemporal and the cranium, almost filling the posttemporal fossa. All the bones of the secondary portion of the pectoral girdle are tightly appressed to each other, and the entire segment fits firmly against the outer surface of the supracleithrum. The radials of the pectoral fin are either three or four separate bones forming a single functional unit or fused to a single element. The pectoral fin has 11—rarely 10 or 12—rays, the first stiff and undivided. The fin is not exceptionally large as in the Exocoetidae but is much longer than in most characids.

The pelvic girdle is small and the pelvic bones lie with their faces parallel. The small size of the pelvic bones and fins make them appear almost functionless.

The caudal region, including the dorsal and anal fins, is not unlike that of other characids; however, there is in general an increase in the number of anal fin rays. The lengthening of this fin undoubtedly serves as an aid in increasing the stability of these oddly shaped fishes.

Relationships of the Gasteropelecinae to Other Characids

The Gasteropelecinae consists of three genera, *Thoracocharax*, *Gasteropelecus*, and *Carnegiella*. Although at present there is no controversy about what genera should be included in this subfamily, their degree of divergence from other characids has not been well understood. Eigenmann (1909a, 1910) included members of the genera *Triportheus* and *Pseudocorynopoma* in the gasteropelecins. At that time Eigenmann considered this group of family rank. Most subsequent American authors—Eigenmann (1909b, 1912), Eigenmann and Allen (1942), Schultz (1944), and Myers (1950)—have excluded *Triportheus* and *Pseudocorynopoma*. Regan (1911) and Fraser-Brunner (1950)

have done the same. Gregory and Conrad (1938) lumped several of Eigenmann's subfamilies including the Gasteropelecinae under the Characinae. In referring to Regan's (1911) placement of *Triportheus* these two authors state, "....we incline to the opinion that *Chalcinus* [=*Triportheus*] is much nearer to the structural ancestor of Gasteropelecins."

The purpose of this section is to show the degree of divergence of the gasteropelecins from recent relatively generalized characids, and to show the relationships or lack of them to characids that might be considered close to gasteropelecins on the basis of an expanded coracoid region and casual inspection.

The Gasteropelecinae are compared with the genera *Astyanax, Brycon,* and *Bryconamericus* to establish the degree of the subfamily's divergence from centralized characids. These genera were chosen as representing the least specialized of recent South American characids and it was thought that characters common to these genera might be considered relatively primitive for living characids, and that they probably closely approximate the ultimate source from which the gasteropelecins developed.

The gasteropelecins are largely defined by characters correlated with functional modifications for flight and surface feeding. Table 1 lists a number of these characters and the corresponding condition in the more generalized characids. These are by no means all the characters differentiating the subfamily. Almost every bone and the corresponding myology and other soft parts of the gasteropelecins differ in details of shape and distribution from those in *Astyanax, Brycon,* and *Bryconamericus.* This is especially true in the head and pectoral regions. The generalized characters in Table 1 have been found in characids other than those listed; see Sagemehl (1885), Starks (1926), Myers (1929), Gregory and Conrad (1938), and Nelson (1949). The cranial fontanel in the gasteropelecins is absent or reduced to a very narrow slit; while in the more centralized characids, as *Astyanax, Brycon, Bryconamericus,* and some of the somewhat specialized offshoots, as *Cheirodon, Pristella,* and *Hemigrammus,* the cranial fontanel is usually present and well developed but may sometimes be much reduced. Evolution of the number of tooth rows in characids in general follows a sequence of reduction in tracing lines from the generalized to the specialized. This is also true within the gasteropelecins as exemplified in the premaxillary tooth rows which are two-rowed in the relatively primitive gasteropelecin forms and one-rowed in the most specialized. *Brycon* has three tooth rows in the premaxillary and *Astyanax* and *Bryconamericus* have two rows.

An examination of the osteological structures in *Triportheus* neither proves nor disproves that the members of this characid genus are related to the gasteropelecins. Superficially *Triportheus* resembles the gasteropelecins in several structural features. Some of these resemblances may indicate relationships; however, there are basic differences between these two groups suggesting that the similarities may be due to convergence or that the genus *Triportheus* and the gasteropelecins may have had a common ancestor. In either case the two groups are now far divergent.

The coracoids of *Triportheus* are expanded so that the thoracic region superficially resembles this region in the gasteropelecins. However, the coracoids of *Triportheus* are not fused; their surfaces are smooth and so closely parallel that they are difficult to separate, not fused and corrugated as those of the gasteropelecins. The lateral wing of the cleithrum is well developed and much like that of *Astyanax, Brycon,* and *Bryconamericus. Triportheus* also retains postcleithra. The supracleithrum and posttemporal of *Triportheus* are separate but otherwise superficially look like those in *Thoracocharax.* The pectoral girdle of *Triportheus* does not possess any specializations that would prevent it from being the source for the derivation of the gasteropelecin girdle; however, this does not mean that it is

Table 1

Comparison of Gasteropelecin Characters
with Conditions in Relatively Unspecialized Characids

	Gasteropelecinae	*Astyanax*, *Brycon*, and *Bryconamericus*
hape of frontal	Longitudinally corrugated, each with median dorsal ridge	Smooth, concave internally, convex dorsally
Epitemporal fossa	Highly reduced to a small area under supratemporal	Covers an extensive region of posterior part of cranium
Orbitosphenoid	Reduced to narrow Y- to V-shaped ossification	Broad, heavy bone covering upper region of orbit
Facial bones	Lower facial bones elongate and thrust forward; jaws almost vertical	Lower facial bones not elongate; mouth terminal (or lower jaw included)
Pharyngobranchials	Three pharyngobranchials modified as suspensory pharyngeals and two as special tooth-bearing plates	One suspensory pharyngeal and four tooth-bearing pharyngobranchials (fourth and fifth modified into special tooth-bearing plates)
Coracoid	Anterior edge firmly sutured to cranium	Loosely applied to exterior of cranium
Epitemporal and supracleithrum	Fused to form single bone	Separate ossifications
Postcleithra	None	Two; one at posterior junction of cleithrum and supracleithrum, the other behind supracleithrum
Cleithrum	Lateral wing reduced to low ridge; anterior portion greatly elongated reaching anterior edge of urohyal, forming floor of branchial region	Lateral wing well developed; anterior portion never reaching anterior edge of urohyal, not forming floor of branchial region
Coracoids	Greatly enlarged, fused to form corrugated median bone	Not expanded, fused, or corrugated
Pelvic bones	Reduced to small, almost functionless units, flat sides parallel	Not reduced, "normal" function retained, flat sides almost in same plane
Lateral line	Extends downward to approach origin of anal fin or reduced to 0-3 scales	Extends longitudinally to caudal peduncle and caudal fin

that source or that it is an offshoot of a common source between the tw groups. The two types of pectoral girdles may have been derived indepeni ently from different sections of the generalized characid stock.

The scales of *Triportheus* closely approach the type found in *Thoraco charax* (Fraser-Brunner, 1951a, p. 967, fig. 4); this gasteropelecin genu is in some respects the most primitive of the subfamily. In *Triportheu* the central, ring-shaped striation is rarely complete, and the radiatin striae are largely confined to the exposed portion of the scale, but th condition resembles that of *Thoracocharax*.

The lateral line of *Triportheus* dips downward toward the origin of th anal fin and then continues onto the caudal peduncle. This suggests affin ity with the gasteropelecins in which the lateral line, when present, end near the origin of the anal fin. The lateral line of *Brycon* has a sligh dip toward the anal fin, and *Triportheus* might be interpreted as being in termediate between the gasteropelecins and *Brycon* in this feature. Agai this may or may not indicate phyletic relationship.

The bones of the lower facial region of *Triportheus* are somewhat elongat and the mouth is oblique; however, these characters are always correlate with expanded coracoids. Basically the cranium of *Triportheus* is of th generalized characid type, nothing like that of the gasteropelecins. Als the pharyngobranchials are essentially like those of the centralized genera

Considering that all the cranial bones of *Triportheus* are essentiall like those of the centralized characids and that those modifications o *Triportheus* that resemble gasteropelecin modifications could be due to con vergence, it can only be concluded that if *Triportheus* is at all related t the gasteropelecins the relationship is remote and near the early gastero pelecin ancestors. *Triportheus* cannot be considered intermediate betwee the gasteropelecins and the centralized characids.

Superficially *Pseudocorynopoma* looks something like *Triportheus;* how ever, the osteological structures of this glandulocaudine characid sugges no direct relationship either with the gasteropelecins or *Triportheus*, al though a certain degree of convergence of characters can be seen, due sole ly to the expansion of the coracoids and enlargement of the pectoral girdle The smooth-surfaced coracoids are perforate, expanded, and appressed to on another and not thin and lamellar as in *Triportheus*. The lower facial bone are hardly elongate and although *Pseudocorynopoma* has several specializa tions of its own, such as five spine-like rays in the anal fin, the caudal gland, and a modified pelvic girdle, its cranial structure and secondar pectoral girdle are essentially like those of the centralized characids

The members of the characid family Cynodontinae have expanded coracoid however, they do not resemble even superficially members of the Gastero pelecinae. Nelson (1949) has described parts of the osteology of *Raphiodo vulpinus* Agassiz, a member of the Cynodontinae, and Schultz (1950) ha listed several characteristics of this subfamily. Although the coracoid of *Raphiodon* are expanded and fused, the pectoral girdle as a whole has a entirely different structure than that found in the gasteropelecins. Th cranium and head bones of *Raphiodon* are highly modified but differ greatl from those in the gasteropelecins. The ethmoid region is elongate; th orbitosphenoid is a heavy, enlarged bone; the posttemporal region retain the large foramina; the supratemporal is not sutured with the cranium; an the shape and arrangement of the posttemporal and secondary shoulder girdl is not at all like that in the gasteropelecins. Further, the teeth o *Raphiodon* and other cynodontins are caninelike, not tricuspid as in the gas teropelecins. Also, members of the Cynodontinae have small, numerous scale

The coracoids of several characid genera are slightly enlarged and ap pressed together at least anteriorly. The anterior ends are in contact *Astyanax, Brycon,* and *Bryconamericus.* In *Paragoniates, Prionobrama, Bryco*

icus brevirostris, and *Mimagoniates* the coracoids are in contact for a- one-half their anterior distance. Most generalized characids so far ined have their coracoids in contact for at least a short distance an- orly. It is quite likely that the development of expanded, appressed coids and elongate fins arose several times from different groups of ralized characids and, in the case of the Cynodontinae, from a special- group of characids.

The Gasteropelecinae probably arose from some generalized characid some- t like *Astyanax*, *Brycon*, and *Bryconamericus*. They have diverged far the generalized condition found in these genera; however, their ori- is from something like the centralized characids can be clearly seen, ce the specialized gasteropelecin characters are modifications of the atively generalized type of structures found in *Astyanax*, *Brycon*, and conamericus. *Triportheus* may or may not be closely related to the stock which the gasteropelecins developed. Enlarged appressed coracoids and ingate pectoral fins probably have arisen several separate times from the tralized characids.

The discussion in the preceding section is based on the examination of following specimens of characids and the gasteropelecin specimens list- in the following section.

Astyanax fasciatus mexicanus (Filippi): 2 alizarin preparations, 20557, SL 51-83 mm., Peñon Blanco, Río Nazas drainage, Durango, México, . 1, 1952, S. Weitzman and A. Solorzano.

Brycon oligolepis Regan: 21 (3 alizarin preparations), CAS 20653 UM 12981), SL 28-106 mm., tributary to Río San Juan, Condoto, Columbia, b., 1913, C. E. Wilson.

Bryconamericus brevirostris (Günther): 1 alizarin preparation, SU 22749, 40 mm., Río Daule, Colimes, Ecuador, Arthur W. Henn.

Bryconamericus ortholepis Eigenmann: 166 (3 alizarin preparations), S (IUM) 13023, SL 18-78 mm., Río San Juan basin, Condoto, Colombia, 1913, E. Wilson.

Cheirodon pisciculus Girard: 96 (5 alizarin preparations), CAS 20655 UM) 15504), SL 20-55 mm., Hospital, Río Angustura, Río Maipo basin, Chile, r. 22, 1919, C. H. Eigenmann.

Hemigrammus nanus (Lütken): 4 alizarin preparations, SU 16462, SL 18.5- mm., feed beds along shore of Lagôa Santa, Minas Gerais, Brazil, Oct. 21, 42, G. S. Myers.

Hemigrammus unilineatus Gill: 1 alizarin preparation, SU 21846, SL 28.5 m., Mora Passage or mud creek below Wismar, British Guiana, 1908, C. H. genmann or S. E. Shidler.

Mimagoniates microlepis (Steindachner): 25+ (4 alizarin preparations), U 47293, SL of alizarin specimens 22-33 mm., Estrado do Mar, 2½-5 km. east Paranaguá, Paraná, Brazil, Mar. 30, 1944, G. S. Myers and A. Carvalho.

Paragoniates alburnus Steindachner: 5 (1 alizarin preparation), Su 7294, SL 41.5-81 mm., Río Amana, 6 km. east of Santa Barbara, 35 km. west Maturin, Venezuela, Mar. 16, 1939, F. F. Bond.

Prionobrama filligera (Cope): 8 (2 alizarin preparations), SU 47295 SL 1-45 mm., Río Morona, tributary of Amazon River, Perú, 1920, W. R. Allen.

Pristella riddlei (Meek): 25+ (2 alizarin preparations), SU 47296, L 18-19 mm., Belém, Pará, Brazil, 1944, G. S. Myers.

Pseudocorynopoma doriae Perugia: 14 (2 alizarin preparations), SU31667, L 43-60 mm., La Plata River, 220 km. north of Buenos Aires, Argentina, une, 1934, A. W. Herre.

Triportheus magdalenae (Steindachner): 28 (3 alizarin preparations), AS 20652 (IUM 12876), SL 26.5-192 mm., Río Magdalena, Calamar, Colombia, an., 1913, C. H. Eigenmann.

Phyletic Relationships Among the Genera and Species of Gasteropelecinae

The phyletic position of the various members of the Gasteropelecinae ha been rather confused and only recently the genera have been redefined on a acceptable basis by Fraser-Brunner (1950a). However, in his account littl attempt was made to show the phyletic arrangement of the genera, and sev eral generic characters can be added to Fraser-Brunner's findings. Hoedema (1952) assumes the genus *Gasteropelecus* to represent the central stock o the living Gasteropelecinae. He bases this on the fact that *Gasteropelecu* retains a short segment of the lateral line at the base of the caudal fin Although this character is undoubtedly primitive for the subfamily, it doe not follow that one primitive feature makes the genus primitive for th group. Hoedeman believes that *Carnegiella* developed from *Gasteropelecus*, a suggested by Fraser-Brunner who noted the superficial resemblance of *Carne giella myersi* to *Gasteropelecus*. Hoedeman also speculates that *Thoraco charax* probably evolved from something near the ancestor of *Gasteropelecus*.

This section is not intended to be an extensive systematic review of th Gasteropelecinae. Rather it is my intent to point out relationships tha previously have been overlooked among the species and genera of this sub family. These relationships were found while determining characters tha distinguish this subfamily from other characids and are presented her solely for the purpose of forming a basis for a sound systematic revie that can only be completed when sufficient material becomes available. Syn onymies are not given since reference to Fraser-Brunner (1950a), Fernande Yepez (1950), and Hoedeman (1952) will provide these. One term is use here that has not been used before in ichthyology: the index of coraco expansion. This may be found by dividing the distance in millimeters be tween the origin of the pectoral fin and the lowermost posterior angle o the coracoid into the standard length.

The key has been made as natural as possible and is an expression of th phyletic relationships discussed in the text.

Key to the Genera and Species of Gasteropelecinae

1a. Pelvic rays i,5, forked rays twice dichotomous; dorsal rays ii,10- or iii,9-14; anal rays ii,32-42 or iii,31-41; scales between th posterior lower angle of the coracoid and the anus about 18 to 2 scales in a longitudinal series 19-22, and with a central annulus a about 8-10 radial striae; premaxillary with two tooth rows, the out row with 3 teeth.....*Thoracocharax* Fowl

2a. Index of coracoid expansion 245-280 in adults; 2-3 rows of scales anal fin; anterior rays of dorsal fin with a basal black blotch.... .....*T. stellatus* (Kne

2b. Index of coracoid expansion 180-195 in adults; 5-6 rows of scales anal fin; anterior rays of dorsal fin with a distal dark area.... .....*T. securis* (Filipp

1b. Pelvic rays i,; or v, forked rays once dichotomous; dorsal rays i 8-10 or iii,7-9; anal rays iii,19-33; scales between the posteri lower angle of the coracoid and the anus 6-9; scales in a longitudir series 25-37, without a central annulus and radial striae or if small central annulus rarely present there are fewer than 8 radi striae; premaxillary with one or two tooth rows, the outer row wh present with only one tooth.

3a. Adipose present; lateral line complete almost to the origin of ar fin; pelvic rays i,4; first orbital bone present; a sensory car embedded in the pterotic bone.....*Gasteropelecus* Gro (See text for a discussion of the species)

). Adipose fin absent; lateral line of 0 to about 3 scales; pelvic rays v (rarely one of these rays once forked); first orbitsl bone absent; bony sensory canal in the pterotic absent.....*Carnegiella* Eigenmann

1a. Second, third, and fifth orbital bones present; anal rays iii, 30-33; maxillary teeth 4-5; radials fused to a single bone..... .....*C. myersi* Fernandez-Yepez

1b. Second and third orbital bones present or absent, but fifth orbital absent, only bony lateral sensory canal tube present in region of fifth orbital; anal rays iii,19-29; maxillary teeth 1-2; three radials firmly united but not fused to a single bone.

5a. Second and third orbital bones present, thorax with wide, rather wavy bars extending obliquely from the coracoid keel toward the dorsal fin.

6a. Second oblique dark band divided most of its length, occurring as a solid band only where it meets the coracoid keel (in very young specimens the undivided portion is longer, approaching the condition in *C. strigata*).....*C. vesca* Fraser-Brunner

6b. Second dark oblique band single for about the lower half of its length..... *C. strigata* (Günther)

5b. Second and third orbital bones absent; no wide wavy bands on the thorax, either flecked with chromatophores or with dark, narrow, upcurved, parallel lines.

7a. Anal rays iii,19-21; thorax with 6 or 7 narrow, upcurved, parallel lines .....*C. marthae* Myers

7b. Anal rays iii,24-26; thorax without lines, speckled with chromatophores .....*C. schereri* Fernandez-Yepez

THORACOCHARAX Fowler

At first sight it might appear that *Thoracocharax* is the most specialed genus because of its deep body and the supposedly peculiar scales deribed by Fraser-Brunner (1950a). However, examination of Table 2 shows at it retains some primitive characters not possessed by the other two nera. Thus the secondary pectoral girdle of *Thoracocharax* is less modiei than those of either *Gasteropelecus* or *Carnegiella;* the premaxillary oth arrangement is less specialized than in the other two genera; and the lvics have six rays, the five divided rays being twice dichotomous. In dition, *Thoracocharax* shares some features with *Gasteropelecus* not possed by *Carnegiella.* Both *Thoracocharax* and *Gasteropelecus* retain: lateral nsory canals in the pterotic; a long bony sensory tube in the upper region the preopercle; the first orbital bone; and the adipose fin. In *Thoracoarax* and *Gasteropelecus* the sensory system in the parietal and posttempal region is more like that in the generalized characids than it is in rnegiella. The lateral line is much longer in *Thoracocharax* and *Gasteroelecus* than it is in *Carnegiella,* and they have four radials whereas rnegiella has only three or one.

The type of scales in *Thoracocharax* may or may not be specialized. The enus *Triportheus* has scales approaching those of *Thoracocharax,* and this y be a primitive feature indicating affinity with some ancestor of both e gasteropelecins and *Triportheus.* The large number of scales, about 20 28 between the posterior lower angle of the coracoid and the insertion the pelvics, is a feature difficult to evaluate, but it is probably a ecialized feature, since the number of scales in *Triportheus* and other ngasteropelecin characids examined are about ten in the corresponding gion. Dorsal and anal fin ray counts and the number of scales in a latral series vary greatly among characids; it is difficult to judge their gnificance in the gasteropelecins. However, basing judgment on the rela-

tively primitive characids examined, the original ancestors of this subfam ily probably had 30 to 40 scale rows in a longitudinal series, about eigh to ten unbranched and branched dorsal rays, and about 12 to 20 unbranche and branched anal rays. Thus it might appear, but it is difficult to b certain, that the high dorsal and anal counts and the low scale count o *Thoracocharax* are specialized characters relative to the other two gener of the Gasteropelecinae. The greater body depth and more forward expansio of the coracoids in *Thoracocharax* is undoubtedly a furthering of a special ization.

From this discussion it can be seen that *Thoracocharax* is the leas specialized genus of the subfamily at least in some features, although i does possess some of its own specializations. Probably *Thoracocharax* wa not derived from either of the other known living genera.

The two species of *Thoracocharax* are closely related. They are alike i all major osteological features and the most reliable characters for thei separation that I have found appear in the key. Fraser-Brunner (1950a pointed out that the pectoral fins of *Thoracocharax stellatus* (Kner) ar shorter, reaching a point behind the origin of the dorsal fin, while th pectoral fins of *T. securis* (Filippi) reach a point behind the insertion o the dorsal fin. In *stellatus* the posterior lower angle of the coracoi lies almost directly below the origin of the pectoral fin, whereas i *securis* it lies well behind the origin of the pectoral. The greates height of the anal fin of *stellatus* is contained about two and eight-tenth times in the head, and only about two times in *securis*. *Thoracocharax securis* is known only from the Amazon basin, whereas *stellatus* is found i the basins of the Amazon and La Plata rivers.

Thoracocharax stellatus (Kner): 37 (9 alizarin preparations), CAS 2065 (IUM 17145), SL 26.5-54 mm., Lake Rogoagua, Bolivia, Nov., 1921, N. E. Pearson; 2, CAS (IUM) 15620, SL 51-60 mm., Gosulimacocha, Río Morona, Perú 1920, W. R. Allen; 2, CAS (IUM) 15619, SL 61-67 mm., Lago Sanango, abov Yurimaguas, Perú, Oct., 1920, W. R. Allen; 27, CAS (IUM) 15621, SL 36-5 mm., Río Morona, Perú, Oct., 1920, W. R. Allen; 5, CAS 20669, SL 41.5-5 mm., Amazon River, Iquitos, Perú, Sept., 1920, W. R. Allen; 9, CAS (IUM 17146, SL 38-55 mm., Rurrenabaque, Río Beni, Bolivia, Oct., 1921, N. E. Pearson; 34, SU 31565, SL 23.5-43.5 mm., San Pedro, 220 km. north of Bueno Aires, Argentina, June, 1934, A. W. Herre.

Thoracocharax securis (Filippi): 1 (alizarin preparation), CAS 2065 (IUM 12859), SL 61 mm., Cudajás, Amazonas, Brazil, 1865 or 1866, Thayer Ex pedition; 1, CAS 11801, SL 55 mm., Rio Jura, Amazonas, Brazil; 1, CAS (IUM 15908, SL 48 mm., "probably" Pébas, Perú; 1, CAS 20670, SL 47.6 mm., Lag Grande, Brazil, Oct., 1924, C. Ternetz; 1, SU 35172, SL 68 mm., Ampiyac River, near Pébas, Perú, 1936, W. G. Scherer; 6 (1 alizarin preparation) SU 34518-34523, SL 58-67 mm., Tuye Caño, Pebás District, Perú, Aug. 28 1936, W. G. Scherer; 2, SU 34533 and 34534, SL 60-60 mm., Ampiyacu River near Pébas, Perú, Sept., 1936, W. G. Scherer.

GASTEROPELECUS Gronow

As shown in the discussion of *Thoracocharax*, *Gasteropelecus* and *Thoracocharax* share several relatively primitive features not possessed by *Carnegiella*. *Gasteropelecus maculatus* Steindachner and *Gasteropelecus levis* (Eigenmann) retain the sixth orbital; occasionally it is present in *Gasteropelecus sternicla* (Linnaeus); and it is always absent in *Thoracocharax* and *Carnegiella*. All three species of *Gasteropelecus* retain a short segment of the lateral line on the caudal fin. This segment appears to be absent in the other genera. The higher number of scale rows in a longitudinal series and the lower number of dorsal and anal fin rays, plus the features men

Comparison of Generic Characters of *Thoracocharax*, *Gasteropelecus*, and *Carnegiella*

	Thoracocharax	*Gasteropelecus*	*Carnegiella*
Secondary shoulder girdle	Posttemporal and supracleithrum fused to a single bone but similar to shape of these bones in *Triportheus*, cf. pp. 225-226	Posttemporal and supracleithrum fused with same condition as in *Carnegiella vesca*, cf. pp. 225-226	Posttemporal and supracleithrum fused with same condition as in *Carnegiella vesca*, cf. pp. 225-226
Lateral sensory system of head	Lateral sensory canal present in pterotic, a bony sensory tube in upper region of preopercle	Lateral sensory canal present in pterotic, a bony sensory tube in upper region of preopercle	Lateral sensory canal over surface of pterotic in the flesh; no bony sensory tube in upper region of preopercle
Orbitals	Always with orbitals 1, 2, 3, and 5	Always with orbitals 1, 2, 3, and 5	Orbitals variously reduced, orbital 1 always absent
Lateral line	Decurves downward to approach origin of anal fin; no short segment on caudal fin	Decurves downward to approach origin of anal fin; short segment on caudal fin	0 to 2 or 3 scales; no short segment on caudal fin
Number of scales in a longitudinal series	19-22	28-37	25-32
Number of scales from insertion of pelvics to posterior lower angle of coracoid	18-28	6-9	6-9
Scale striations	Scales along midsides with a central circle and radiating striae	Scales along midsides very rarely with a central circle; striae present	Scales along midsides very rarely with a central circle; radiating striae present
Premaxillary teeth	Outer row 3; inner row 7	Outer row 0-1; inner row 7-9	Outer row 0; inner row 8-11
Radials	4	4	3 or 1
Dorsal fin	ii,10-15; or iii,9-14	ii,8-10; or iii,7-9	ii,6-8; or iii,5-7
Anal fin	ii,32-42; or iii,31-41	iii,23-33	iii,19-33
Pelvic fin	i,5; branched rays twice dichotomous	i,4; branched rays once dichotomous, rarely a rudimentary ray adnate to last ray	v; rarely one of the rays once dichotomous
Adipose fin	Present	Present	Absent

tioned above, indicate that although *Gasteropelecus* may be somewhat mor specialized than *Thoracocharax* in some features, it does retain some prim tive structures not possessed by the latter. Thus the two genera probabl arose from a common ancestor; each genus has its own peculiar specializa tions; and each retains a few primitive structural characters not possesse by the other.

The classification of *Gasteropelecus* is in an unsatisfactory state; fo the present three valid species are retained on a tentative basis. Th first of these, *Gasteropelecus maculatus* Steindachner, occurs in th Pacific drainages of Panamá from the Río Chorrera eastward; in the Atrato San Juan, and Magdalena basins of Colombia; and in the Maracaibo basin i Venezuela. Specimens from some of these basins appear slightly differen in body shape and color pattern; however, proper treatment of these form will have to await the comparison of sufficiently large series of specimen from these basins. In addition, material all preserved in the same manne so that color descriptions and proportions can be comparative would be ver helpful. Until this can be done it is best to consider all these popula tions as one species, for I have been unable to find any characters tha will reliably distinguish all specimens at hand of one population from al of the other populations. *Gasteropelecus maculatus* seems to be the mos primitive living member of the genus. At least it retains a few more prim itive features than the other species. Thus it has four or five maxillar teeth, a sixth orbital bone, and two rows of premaxillary teeth.

Unfortunately the systematic status of *Gasteropelecus sternicla* (Linnaeus has become rather confused and involved. Fraser-Brunner (1950a), on th basis of specimens in the British Museum and a review of the literature decided that *G. sternicla* is endemic to the Guianas, since he felt that th identification by Eigenmann and Allen (1942) of *G. sternicla* from Perú wa erroneous. Basing his opinion on Allen's description (in Eigenmann an Allen, 1942) of *G. coronatus* from Perú, he further decided that this spe çies would probably eventually prove to be conspecific with *G. levis* of th lower Amazon basin. As Fraser-Brunner did not have specimens of *G. coron atus*, and considering the geographic ranges of the forms involved, his pre diction seems logical. As will be explained below, examination of Allen type material of *G. coronatus* showed this species to be a synonym of *G sternicla*. However, before this information could be published Hoedema (1952), apparently without factual basis for his conclusions, considered *sternicla* to consist of five subspecies: *G. sternicla* (Linnaeus) fro Surinam (Hoedeman "restricted" this generalized locality to Paramaribo *G. s. marowini* Hoedeman from the Marowini basin in Surinam, *G. s. mor* Hoedeman from British Guiana, *G. s. levis* (Eigenmann) from the lower Amaz basin, and *G. s. coronatus* Allen from the vicinity of Iquitos, Perú. A though it is difficult to understand precisely Hoedeman's criteria for sp cies or subspecies, his tables indicate that if average differences ar found in comparing measurements and counts between populations, the popul tions can be separated as subspecies. Statistically this is an incorre procedure for comparison of the degrees of morphological or any other d vergences among two or more populations. Subspecific names based on such procedure cannot be considered valid until a correct statistical procedu is used, and the geographical ranges are understood. Until collections adequate numbers of specimens from adjacent localities throughout the ran of *G. sternicla* can be compared to see if subspecies exist, *G. s. morae* a *G. s. marowini* must remain in the synonymy of *G. sternicla*.

In attempting to determine the status of *Gasteropelecus coronatus*, se eral confusing factors arose. The type locality and the type specimen a in some doubt. In Eigenmann and Allen (1942) Allen (p. 267) designated t type as a specimen "47 mm. from mandibular symphysis to end of mid caudal rays, type, brook, Rio Itaya, near Iquitos, September, 1920".

e 457, plate XIV, figure 4, is a photograph of a specimen labeled as lows on page 456: "*Gasteropelecus coronatus* Allen, sp. nov.——, 35 mm., Haullaga, Yurimaguas." In a jar containing the types at the California demy of Sciences are five specimens. A label in this bottle designates largest specimen as the type. This specimen, a female 37 millimeters standard length is the same fish as is shown in Allen's photograph on e 457. The caudal fin is broken and it is now impossible to measure s specimen as Allen measured his type; however, it appears that this sh would be about 45 to 47 millimeters when measured in that way. Apparly this specimen is the holotype. The label in this bottle designates e locality as Yurimaguas, Perú. Two specimens in excellent condition llected by Dr. Allen in brooks near Río Itaya, above Iquitos, Perú (the e locality mentioned by Allen on page 267), are too large to be the type d no other specimen from near Iquitos could be found. Apparently the e locality is Río Haullaga, Yurimaguas, Perú, and the type specimen is e fish figured by Eigenmann and Allen on page 457.

As described by Allen, *G. coronatus* would be distinct from all other steropelecins in the absence of pelvic fins and in possessing about nine ys in the pectoral fins (gasteropelecins have rarely ten, almost always even, or rarely twelve rays in the pectoral fin). However, examination Allen's type, and other material collected by Allen from Perú, reveals e presence of pelvics like those of the genus *Gasteropelecus*, and there e eleven pectoral rays. In other generic characters the specimens also t the genus *Gasteropelecus*. Allen also states, "adipose fin present, ak and feebly rayed, more in the nature of a second dorsal." As far as I n tell the adipose fin is like that of other gasteropelecins; when it is esent it is completely without rays.

The most distinctive feature mentioned by Allen that would separate *G. ronatus* from *G. sternicla* is the presence of one maxillary tooth; however, the type has two maxillary teeth on each side (one tooth is broken f on the left side). Of 53 specimens of the Peruvian material examined, e maxillary tooth-count ranged from one to five, the usual number being om two to three. However, this count is somewhat unreliable because most the specimens are somewhat eroded and it is difficult to determine without staining that a tooth has been lost. Twenty-five specimens of *sternicla* rom British Guiana have a maxillary tooth-count of two to five, usually ree to four. In other characters such as color, fin counts, premaxillary d dentary tooth-counts, and body proportion I could find no differences the specimens examined from Perú and British Guiana. Likewise, examinaion of the cleared and stained material from both localities showed no fferences. Thus *coronatus* must be considered a synonym of *sternicla*. llen himself identified some of his Peruvian material as *sternicla*.

Fraser-Brunner (1950a) doubted Allen's record for *G. sternicla* and ought *sternicla* to be restricted to the Guianas. Material in hand makes t appear that *sternicla* is found in two separate areas, the Peruvian azon and the Guianas. In addition I have two specimens from the lower rinoco basin in Venezuela. So far as is known, *sternicla* does not occur the lower Amazon basin, being replaced there by *levis*. Superficially *sternicla* and *levis* look much alike in body shape and color pattern, suggesting close affinity. However, *levis* does not have maxillary teeth and sually retains one tooth in an outer row on the premaxillary. Also *levis* sually has a sixth orbital bone. *G. sternicla* usually has two to four axillary teeth, very rarely a tooth in an outer row on the premaxillary, d rarely possesses a sixth orbital. I have seen no specimens of *sternicla* thout at least one tooth in the maxillary. Both *sternicla* and *levis* are pecialized in different directions in tooth and orbital bone reduction, d in this respect seem more specialized than *G. maculatus*. Whether the aintness of the color pattern of *sternicla* and *levis* is associated with

relative primitiveness or specialization cannot be said. However, on might conjecture that since the member of the genus which retains the larg est number of primitive features also has a strong color pattern, th faintness of that pattern in *G. sternicla* and *G. levis* might be considere (or rather "speculated" to be) specialized.

In summary, three species of *Gasteropelecus* are tentatively retained- *maculatus, sternicla,* and *levis. G. levis* seems to be the most distinct since specimens examined of this species always lack maxillary teeth where as all specimens of *maculatus* and *sternicla* examined have maxillary teeth In color pattern *levis* is like *sternicla;* however, in the presence or ab sence of the sixth orbital bone and the outer maxillary tooth *levis* is in termediate between *maculatus* and *sternicla.* Specimens at hand of *maculatu* could not always be reliably distinguished from specimens of *sternicla* ex cept by a combination of characters. The most valuable characters tha distinguish these two forms are: one tooth in the outer row of premaxil lary teeth, the presence of a sixth orbital bone, and a darker color pat tern in *maculatus. Gasteropelecus sternicla* almost always lacks the oute maxillary tooth row and the sixth orbital, and has a lighter color pattern Also *maculatus* usually has a greater body depth than *sternicla,* althoug specimens of *maculatus* from Panamá and the Maracaibo basin show an overla in this character with specimens of *sternicla* from British Guiana and Perú Proper comparison of sufficient numbers of specimens of *Gasteropelecus* fro all drainage basins throughout its range will probably show that this genu consists of one species, *sternicla,* and several subspecies.

Gasteropelecus maculatus Steindachner: 2, CAS (IUM) 14036, formerl USNM 7859, SL 50.5-51 mm., El Capitan, Río Mamoní, tributary of Río Bayan Panamá, Mar. 20, 1912, S. E. Meek and S. F. Hildebrand; 10, CAS (IUM) 1300 SL 46-59 mm., small creek near Boca del Dineho, Río Colima, tributary o Río San Juan, Colombia, 1913, Arthur Henn; 4, CAS(IUM) 130031, SL 42-47 mm Raspadura, Río Atrato basin, Colombia, 1913, C. E. Wilson; 26 (7 alizar preparations), CAS 20649 (IUM 13004), SL 32-59 mm., Quibdó, Río Atrat basin, Colombia, 1913, C. E. Wilson; 87, CAS (IUM) 13005, SL 25-53 mm., R Truandó, tributary of Río Atrato, Colombia, 1913, C. E. Wilson; 1 [paraty of *G. magdalenae* (Eigenmann)], SL 40.7 mm., Girardot, Río Magdalena basi Colombia, Feb. 9-11, 1911, C. H. Eigenmann; 11, SU 47292, SL 38-46.5 mm tributary of Río Monay, 40 km. north of Trujillo, Maracaibo basin, Venezuel Mar. 14, 1938, F. F. Bond.

Gasteropelecus sternicla (Linnaeus): 4 (1 alizarin preparation), C 20647 (IUM 11666), SL 44-50 mm., mud flats of Demerara River, below Wisma British Guiana, 1908, C. H. Eigenmann; 7, CAS 20678, SL 37-50 mm., Demera River, Wismar, British Guiana, 1908, C. H. Eigenmann; 8 (2 alizarin prepa ations), CAS 20679 (IUM 11669), SL 32-45 mm., trenches of Morawhann British Guiana, 1908, S. E. Shidler; 3, CAS 20680 (IUM 11670), SL 37-4 mm., mud creek into Aruka River, British Guiana, 1908, S. E. Shidler; CAS 20681 (IUM 11668), SL 38-40.6 mm., Mora Passage, British Guiana, 19 S. E. Shidler; 1, SU 47298, SL 35.5 mm., 30 km. east of Upata, Venezuel Mar. 12, 1939, F. F. Bond; 1, SU 47299, SL 34 mm., 3 km. east of El Call Venezuela, Mar. 13, 1939, F. F. Bond; 1 (holotype of *G. coronatus* Aller CAS 20671, SL 37 mm., and 4 (paratypes of *G. coronatus* Allen), CAS 206 SL 30.5-36.5 mm., Río Huallaga, Yurimaguas, Perú, 1920, W. R. Allen; 2, C 20673, SL 46.5-53 mm., brooks near Río Itaya, Iquitos, Perú, Sept., 19 W. R. Allen; 6, CAS 20674, SL 32-42 mm., Contamana, Perú, 1920, W. R. All 33 (5 alizarin preparations), CAS 20675, SL 31.5-38.5 mm., Río Hualla Yurimaguas, Perú, Nov., 1920, W. R. Allen; 1, CAS 20676, SL 37 mm., cr near Yurimaguas, Perú, Nov., 1920, W. R. Allen; 2, SU 17254, SL 34.6-3 mm., Río Ampiyacu, near Pébas, Perú, Nov. 28, 1940, W. G. Scherer; 3, 34535-34537, SL 46.5-49.5 mm., Tuye Caño, Pébas district, Perú, Aug. 1937, W. G. Scherer; 1, SU 34538, SL 46.5 mm., Shansho Caño, Pébas distri

rú, Feb. 9. 1937, W. G. Scherer; 1, SU 34539, SL 34.6 mm., Shansho Caño, bas district, Perú, Aug., 1936, W. G. Scherer.

Gasteropelecus levis (Eigenmann): 1 (paratype). CAS 20677, SL 31 mm., rá, Brazil, J. C. Brevoort; 19 (2 alizarin preparations), SU 26519, SL -41 mm., locality uncertain, possibly Manáos, Brazil, W. Ladiges.

CARNEGIELLA Eigenmann

Carnegiella may be considered a specialized offshoot of *Gasteropelecus*. amination of Table 2 shows that *Carnegiella* is like *Gasteropelecus* in veral features but differs in structural losses. Thus *Carnegiella* has st most of the lateral line and has a reduced lateral sensory canal sys- em of the head and preopercle; the first orbital is always missing in *rnegiella*. It has a reduced number of radials, and the five rays of the lvics are no longer divided (except rarely one split ray may be found). *rnegiella* may be broken into three groups, based to a large extent on the mber of orbital bones present in the member species.

The first of these groups consists of but one species, *Carnegiella myersi* rnandez-Yepez. It may be distinguished from the other two groups by the esence of the second, third, and fifth orbital bones, 33 to 36 anal rays, ur to five maxillary teeth and the fact that the radials are fused into a ingle element. In all but the last of these features *myersi*, more than ny other member of this genus, approaches *Gasteropelecus maculatus*, the ost primitive living member of *Gasteropelecus*. Furthermore, all members f *Gasteropelecus* have one and one-half scale rows on the base of the anal in whereas all members of *Carnegiella* except *myersi* have only one-half of scale row on the base of the anal fin. *Carnegiella myersi* has one-half o one and one-half scale rows, an intermediate condition.

The next group consists of two species, *Carnegiella strigata* (Günther) nd *C. vesca* Fraser-Brunner; probably both will prove to be subspecies of *. strigata*. These fish have lost the fifth orbital bone but have retained he bony sensory tube in this region. Also, the second and third orbital ones are retained. In addition there is only one maxillary tooth (rarely wo), 23 to 32 anal rays, and the radials are only reduced to three separ- te bones.

Carnegiella strigata (Günther) was regarded by Fraser-Brunner (1950a) as consisting of two subspecies, *C. s. strigata* (Günther) from the Amazon asin and *C. s. vesca* Fraser-Brunner from British Guiana. Günther's (1864) ype material is in poor condition, the color pattern can no longer be seen, the type locality is not known, and the original description is in- sufficient for identification. However, Fraser-Brunner examined the types nd regarded them as belonging to the Amazonian form.

Fernandez-Yepez (1950) believed the two forms to be specifically dis- tinct and interpreted Günther's type material as being from British Guiana. He thus considered *Carnegiella fasciata* (Garman) to be the available name for the Amazonian form and *Carnegiella strigata* (Günther) for the British Guiana form (apparently the latter form also occurs in the Amazon basin, as Fernandez-Yepez records two specimens from Cuiabás, Brazil). Fernandez-Yepez did not see the type material and based his opinion on Günther's statement, "Thorax with four blackish bands radiating from the middle of its convex edge." If one counts the bands according to Fernandez-Yepez' system there are three bands, but if the anal band is included (it also radiates from near the base of the coracoid keel) there are four bands. Depending on what system is used, from three to five bands can be counted on the British Guiana form. Since Fraser-Brunner examined the types and regarded them as the Amazonian form it is best to follow his opinion.

As presented by Fernandez-Yepez, maxillary tooth-counts for these two

species give a range of five to ten teeth for the strictly Amazonian form and 16 to 20 for the British Guiana-Amazonian form. This would appear to be an excellent character for distinguishing these forms and would serve to place them at the specific level if no intergradation occurs. However, past the fifth or sixth tooth the teeth become so small as to be almost impossible to count on unstained specimens and care must be taken that the smaller replacement teeth are not counted. Fernandez-Yepez' counts seem to be in error even though his counts were made by clay impressions. Tooth counts by staining with alizarin give the following very different results. Five specimens from Iquitos, Perú, of *Carnegiella strigata* (CAS 20078) have 11, 11, 12, 11, and ? (partially destroyed) teeth on the left side and ? (partially destroyed), 10, 11, 10, and 11 teeth on the right side of the lower jaw. Specimens of *C. vesca* from Gluck Island, British Guiana, (CAS 20645) have 14, 11, 13, 13, 12, and 12 teeth on the left dentary and 13, 12, 12, 12, 12, and 13 teeth on the right dentary. Thus these two forms are closely related and can only be reliably distinguished on the basis of color.

Proper placement of these two forms at the specific or subspecific level must await collection of adequate material from localities in which the ranges of these forms overlap to see if intergradation occurs. Until intergrades are found and sufficiently described from adequate material, it seems best to regard *Carnegiella strigata* (Günther) and *C. vesca* Fraser-Brunner as full species.

Hoedeman (1952) listed five subspecies of *Carnegiella strigata: C. S. fasciata, C. s. strigata, C. s. vesca, C. s. marowini,* and *C. s. surinamensis*. The last two were described by him from the Marowini and the Surinam river systems, respectively. In his account Hoedeman divided *C. strigata* (Günther) of the Amazon into two forms, *C. s. fasciata* (Garman) and *C. s. strigata* (Günther). He also considered Fernandez-Yepez' two examples of *Carnegiella* from Cudajás, Brazil, that are referable to *C. s. vesca* Fraser-Brunner as being *C. s. strigata* (Günther). Moreover, Hoedeman attempted to "restrict" the type locality of Günther's specimens of *C. strigata* to Manáos, Brazil. Needless to say, the type locality of Günther's *C. strigata* still remains unknown, and it should be pointed out that Hoedeman did not see any of the type material involved. In attempting to evaluate Hoedeman's two new subspecies, it is difficult to see what differences he found. His tables show broadly overlapping differences between his two new subspecies, and he lacked material and data to distinguish them from other species of this genus. The descriptions of *C. s. marowini* and *C. s. surinamensis* are so incomplete that it is difficult to place them. Apparently *C. s. marowini* is a synonym of *C. vesca,* for Hoedeman cites Boeseman's (1952) record of *C. s. vesca* from the Marowini basin as referable to *C. s. marowini*. Hoedeman (1951) published a rather poor line drawing of *C. s. surinamensis* called *'Carnegiella strigata* intermediate form.' In general aspect Hoedeman's (1951) picture of *C. s. surinamensis* resembles *C. strigata* (Günther); however, the body depth is less than that shown for *C. vesca* Fraser-Brunner in the same plate, whereas *C. strigata* usually has a body depth greater than that of *C. vesca*. In his key Hoedeman indicates that *C. s. surinamensis* is colored like *C. vesca*. This fish may be an intermediate form between *C. strigata* (Günther) and *C. vesca* Fraser-Brunner, or conceivably may even represent a new species. All that can be done at present is to retain *Carnegiella strigata* (Günther) and *Carnegiella vesca* Fraser-Brunner as separate species, and questionably assign *C. strigata surinamensis* to the synonymy of *C. vesca* Fraser-Brunner.

The third group consists of *Carnegiella marthae* Myers and *C. schereri* Fernandez-Yepez. Probably the latter will be found to be a subspecies of the former. These are closely allied to the second group above and differ chiefly in color pattetn and in the lack of thr second and third orbital bones. Hoedeman (1951) regarded *C. schereri* as a subspecies of *C. strigata;*

however, the characters pointed out here and those in Fernandez-Yepez' original description show conclusively that this fish is closely related to *C. marthae*.

In discussing the relationships of these three groups to each other and to *Gasteropelecus* it is necessary to discuss color patterns in these two genera. First, it should be pointed out that there is a basic color pattern running through all members of both *Gasteropelecus* and *Carnegiella*. This pattern can best be seen in *Carnegiella marthae* (see Fernandez-Yepez, 1950, fig. 4, p. 173). Using Fernandez-Yepez' terminology, this pattern consists of: the horizontal band, the mandibular band, a band below the mandibular band which radiates from the eye to about the origin of the branchiostegal rays, band one which continues from the thorax over the opercular apparatus to behind the eye, the upcurving parallel lines on the thorax that follow the rows of scales, and the anal band. *Carnegiella schereri* is closely related to *marthae* and has almost the same color pattern except that the parallel upcurved bands seem to be absent. *Carnegiella strigata* and *vesca* have the same color pattern except for the addition of bands two and three. The parallel upcurved lines on the thorax can be made out easily on living specimens (Fig. 1, A). The color pattern of *C. myersi* more closely approaches that of *marthae* than Fernandez-Yepez' figure shows. Although the specimens of *C. myersi* are faded and band one seems to be absent, the rest of the basic color pattern is present and the melanophores on the thorax are arranged in upcurving parallel rows. Specimens of *Gasteropelecus maculatus* from the Río Monay of the Maracaibo basin, Venezuela, have the basic pattern of *Carnegiella marthae* but with the addition of heavy spotting on the sides. Instead of about seven to eight upcurved parallel bands as in *C. marthae*, *Gasteropelecus maculatus* has about 15 of these bands corresponding to the higher number of scale rows on the thorax. *G. sternicla* also possesses the basic color pattern but it is very light and is best seen in living specimens. Indeed, it is often completely absent in faded preserved specimens. Preserved specimens of *G. levis* seem to have the same pattern as *sternicla*. The possession of this basic pattern in both *Gasteropelecus* and *Carnegiella* is distinct evidence of their close relationship.

In discussing the relative phyletic positions of the species of *Carnegiella* and their relationships to *Gasteropelecus*, there are several difficulties. First, in general *Carnegiella myersi* seems to be the most primitive, but its color pattern may be somewhat modified and the radials are certainly modified. In the high number of anal rays it closely approaches *Gasteropelecus maculatus;* however, the high maxillary tooth-count could be referred in relationship to either *maculatus* or *sternicla*. In addition it is very difficult to evaluate the stability of such characters, as some of them may have been altered first in one direction and then in another in the course of the evolution of gasteropelecin populations. In view of the fact that *G. maculatus* is probably the most primitive species of that genus, it would seem possible that *Carnegiella* in the past developed from an ancestral stock near that species. In this connection it should be noted that Hildebrand (1938) reported a specimen of *G. maculatus* from Jugua, Panamá, without an adipose fin. The other two groups of *Carnegiella* have several characters in common, and differ only in the orbital bones and color pattern. They probably had a common origin from an extinct section of *Carnegiella* that was nearer to the ancestors of *myersi* than the known recent members of these two groups. Once again it is difficult to say which of these groups is most specialized. *Carnegiella marthe* and *schereri* seems to have a more primitive color pattern, but the loss of orbital bones two and three is certainly a specialized condition. The converse condition is true for *strigata* and *vesca*.

In summary the genus *Carnegiella* is an offshoot of the genus *Gasteropelecus*. Of the described recent species of *Gasteropelecus, maculatus*

seems the closest to the genus *Carnegiella*. It is also the most primitive member of *Gasteropelecus*. *Carnegiella myersi* is the most primitive member of the genus *Carnegiella* and is closest to *Gasteropelecus maculatus*. The two groups formed by *Carnegiella marthae* and *schereri* on the one hand and *strigata* and *vesca* on the other are closely related and are on the whole somewhat more specialized than *myersi*.

Carnegiella myersi Fernandez-Yepez: 1 (holotype), SU 16120, SL 20 mm., creek near Yurimaguas, Perú, Nov., 1920, W. R. Allen; 5 (paratypes), SU 16053, SL 19.5-22 mm., creek near Yurimaguas, Perú, Nov., 1920, W. R. Allen; 5 (1 alizarin preparation)(paratypes), CAS 20081, SL 20.2-22 mm., creek near Yurimaguas, Perú, Nov., 1920, W. R. Allen; 1 (alizarin preparation), CAS 20646. SL 23 mm., Río Huallaga, Yurimaguas, Perú, 1920, W. R. Allen.

Carnegiella strigata (Günther): 14 (5 alizarin preparations), CAS 20078, SL 22-25.5 mm., brook near Iquitos, Perú, 1920, W. R. Allen; 6, CAS 20683, SL 22.5-28 mm., pond near Iquitos, Perú, Sept., 1920, W. R. Allen; 1. CAS 20684, SL 25 mm., Belém, Pará, Brazil, May, 1924, C. Ternetz; 11, SU 16286, SL 24.5-29 mm., ponds and creeks near Iquitos, Perú, Sept., 1920, W. R. Allen; 1, SU 17256, SL 22 mm., Río Ampiyacu, near Pébas, Perú, Nov. 28, 1940, W. G. Scherer.

Carnegiella vesca Fraser-Brunner: 16 (7 alizarin preparations), CAS 20645 (IUM 11785), SL 21-27 mm., woodland brook on Gluck Island, Essequibo River, British Guiana, Sept. 30, 1908, C. H. Eigenmann; 9 (2 alizarin preparations), CAS 20401 (IUM 11788), SL 25.5-31 mm., creek below Potaro Landing, Potaro River, British Guiana, 1908, C. H. Eigenmann; 4, CAS 20079 (IUM 11787), SL 25.3-27 mm., Tumatumari, Potaro River, British Guiana, Oct., 1908, C. H. Eigenmann; 12, CAS 20685 (IUM 12253), SL 19.5-28 mm., Rockstone, Essequibo River, British Guiana, 1908, C. H. Eigenmann; 5, CAS 20686 (IUM 11786), SL 26.5-27.4 mm., Malali, Demerara River, British Guiana, 1908, E. S. Shidler; 2, SU 21822, SL 18-20 mm., Maduni Stop-off, Mahaica River, British Guiana, 1908, C. H. Eigenmann.

Carnegiella marthae Myers: 1 (holotype), CAS 20082 (IUM 17685), SL 20.8 mm., Caño de Quiribana, Venezuela, 1925, C. Ternetz; 4, CAS 20083, SL 19.5-22.4 mm., Caño de Quiribana, near Caicara de Orinoco, Venezuela, 1925, C. Ternetz; 2 (paratypes), CAS 20084, SL 21-22.7 mm., Caño de Quiribana, opposite Pan de Azucar, Venezuela, May 7, 1925, C. Ternetz.

Carnegiella schereri Fernandez-Yepez: 1 (holotype), SU 36491, SL 17.3 mm., Caño del Chancho, Pébas, Perú, July 15, 1936, W. G. Scherer; 1 (paratype), SU 16055, SL 18 mm., Lake Hyanuary, Brazil, Jan., 1866, Thayer Expedition; 1, SU 17255, SL 26 mm., Quebrada Yaquasyacu, near Pébas, Perú, July 24, 1941, W. G. Scherer; 1 (alizarin preparation), SU 47291, Río Ampiyacu, near Pébas, Perú, Aug. 16, 1940, W. G. Scherer.

Summary

1. The gasteropelecins are small, fresh-water, characid fishes living close to the water's surface where they feed on insects and escape their enemies by means of short flights. The "buzzing" sound of the pectoral fins of a gasteropelecin, *Carnegiella vesca*, is recorded for the first time.

2. The detailed osteology of *Carnegiella vesca* is presented, based on seven specimens from a brook on Gluck Island, British Guiana, collected by C. H. Eigenmann during 1908.

3. Osteological characters that occur in the three genera of Gasteropelecinae are discussed in relation to the modified feeding and flight habits of these fishes. The entire skull and pectoral girdle of these fishes are highly modified for feeding on insects at the water's surface and making short flights. The mouth is almost vertical and the lower half of the skull is elongated. The frontals are constructed to resist force

om the lower jaw applied to their own plane. The sphenoid arch is re-
ced, since it is no longer needed to transfer force from the closing jaw
the base of the cranium. This force is transferred to the cranial base
the parasphenoid. Structures involved in hearing and balance are en-
rged and the Weberian apparatus is partially covered by the exoccipitals.
e secondary portion of the pectoral girdle has been modified to attach
re firmly the primary portion to the skull. The primary portion of the
ctoral girdle is greatly modified for the function of flight. The pelvic
rdle is reduced to an almost functionless unit, probably serving as part
the stabilizing keel formed by the ventral scales and anal fin.

4. The Gasteropelecinae is compared with less specialized characids and
s found to differ from them in many conspicuous specialized characters as-
ociated with modified habits. These characters are compared in Table 1.
riportheus is compared with the Gasteropelecinae and found to differ from
t in many basic osteological features, being much more like the less spec-
alized characiis considered in Table 1. *Triportheus* may be remotely re-
ated to the Gasteropelecinae or it may have been evolved separately. An
xamination of its osteology neither proves nor disproves either hypothesis.
seudocorynopoma and the subfamily Cynodontinae were compared with the
asteropelecinae and no relationship was found. It was further pointed out
hat several genera of characiis have coracoids appressed at least anteri-
rly and that a number have coracoids somewhat expanded and pectoral fins
lightly enlarged. It is probable that this condition which gave rise to
ish like the gasteropelecins or *Triportheus* could have arisen several sep-
rate times in the evolution of characids.

5. Several previously unrecorded characters separating the genera and
pecies of the gasteropelecins are presented. The phylogenetic signifi-
ance of these characters and the phyletic relationships of the genera and
pecies are discussed. The genera *Thoracocharax* and *Gasteropelecus* are the
most primitive, each with its own specializations and primitive features
ut both sharing primitive characters not found in *Carnegiella*. *Carnegiella*
eveloped from *Gasteropelecus* and differs from it in the losses of struc-
ures indicated in Table 2.

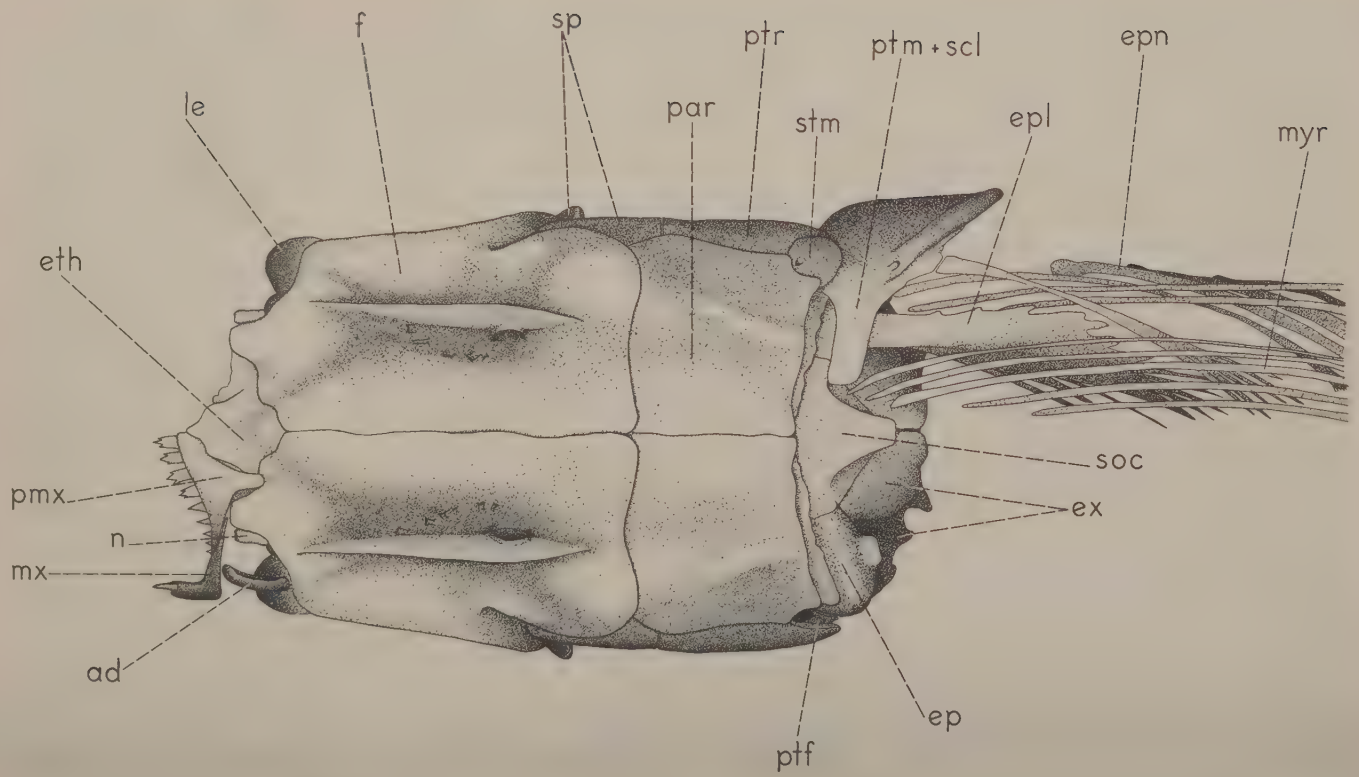


FIG. 2. Cranium of *Carnegiella vesca* with upper jaw, nasal bone, and adnasal of the left side (dorsal view). X 15. The secondary pectoral girdle and intermuscular bones are shown on the posterior right side.

FIG. 3. Cranium of *Carnegiella vesca* (lateral view). X 15.

Fig. 4. Cranium of Cornudella nasca showing parts of the upper jaw and palatine arch (ventral view) X 15.

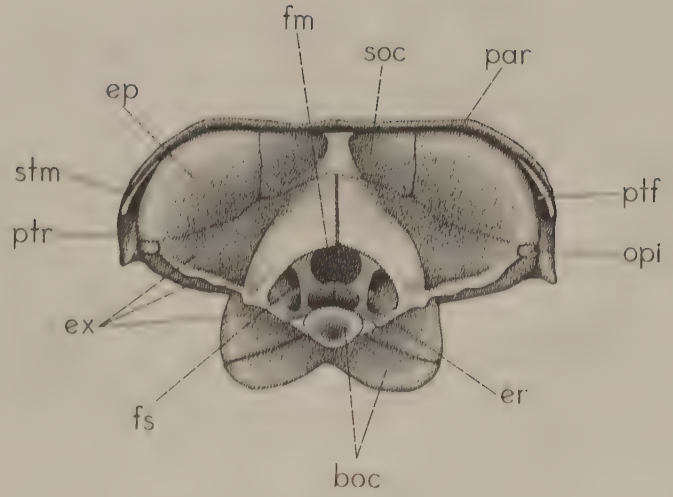


FIG. 5. Cranium of *Carnegiella vesca* with supratemporals (posterior view). X 15.

FIG. 6. Otoliths of *Carnegiella vesca*, left side (upper, external views; lower, internal views). X 60.

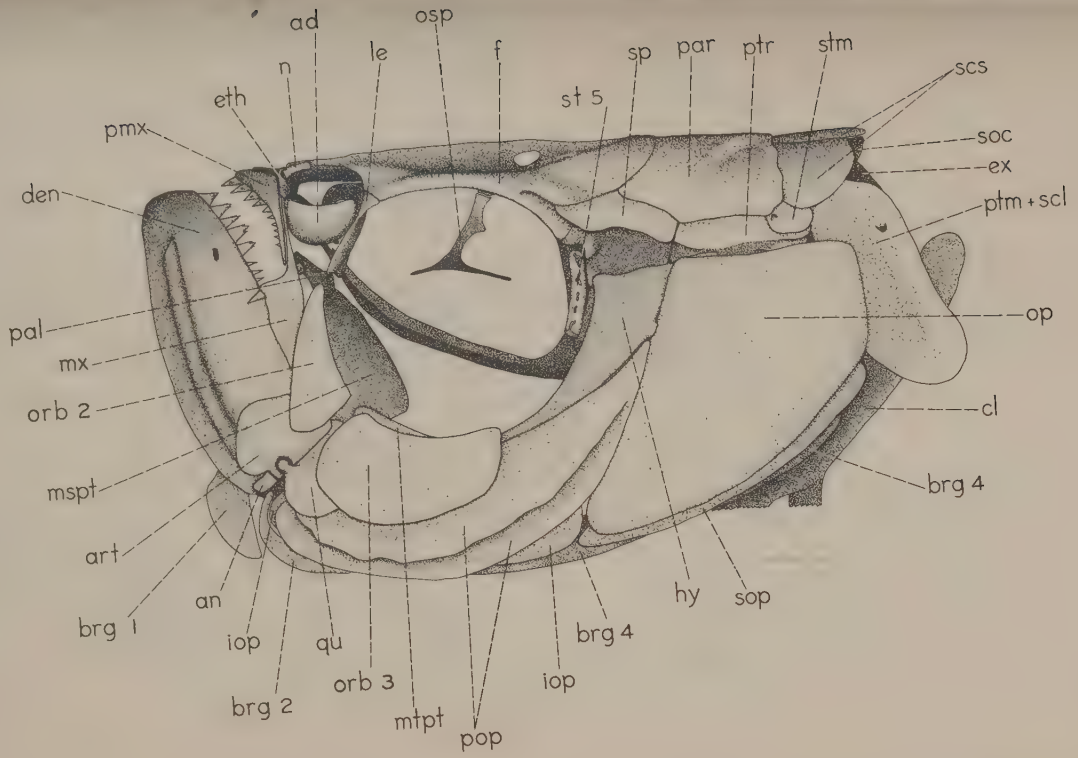
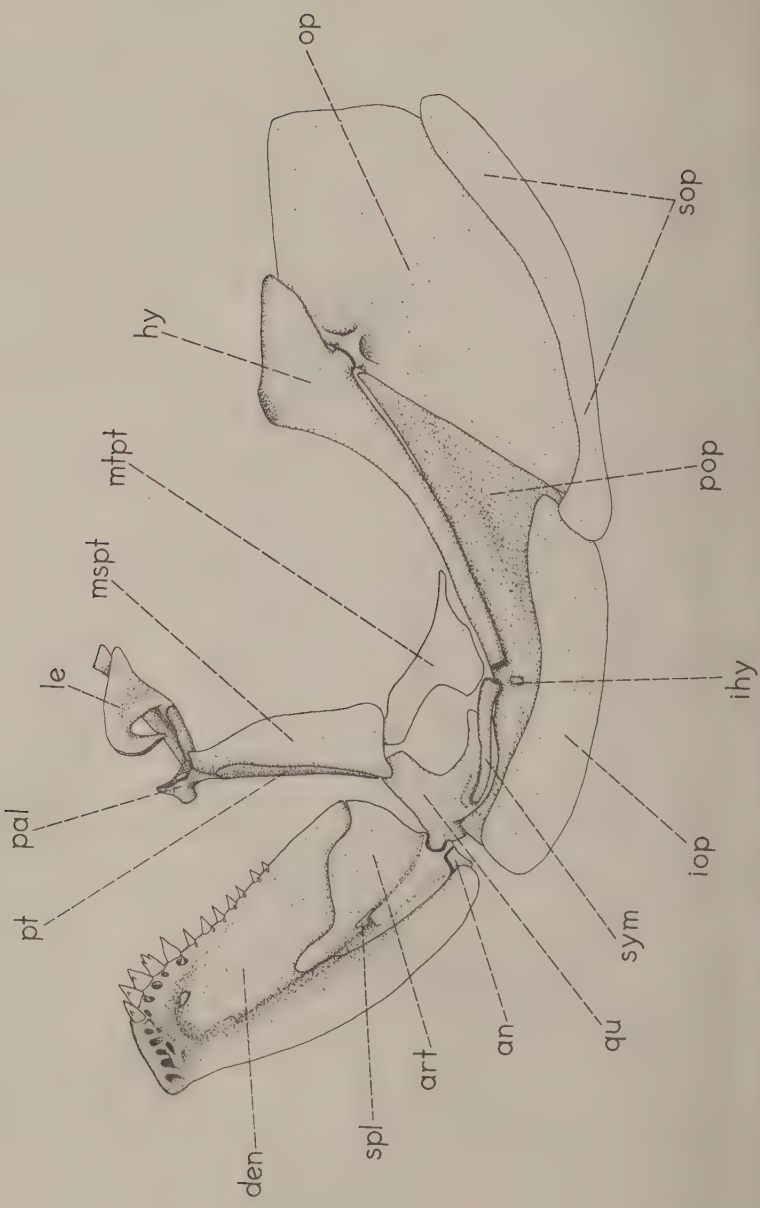


FIG. 7. Skull of *Carnegiella vesca* with upper portion of pectoral girdle (lateral view). X 12.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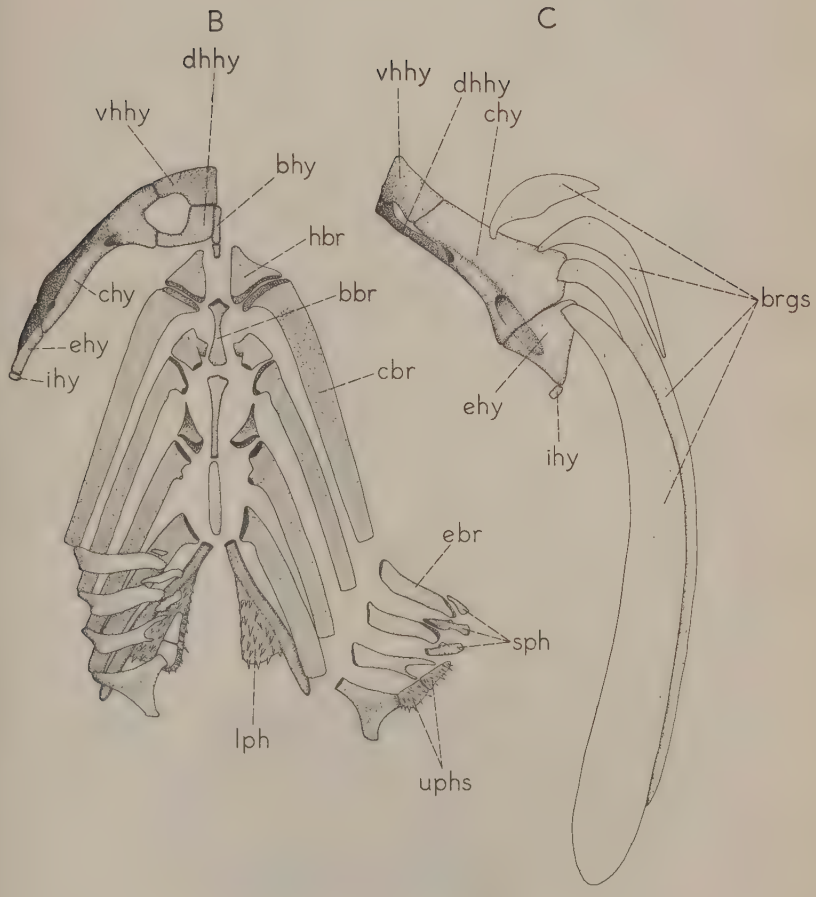

FIG. 9. Hyobranchial apparatus of *Carnegiella vesca*. X 15. A. Urohyal (lateral view). B. Hyoid arch (left side) and branchial arches (dorsal view). Upper branchial elements of right side shown in ventral view. C. Hyoid arch and branchiostegals (right side, lateral view).

FIG. 10. Weberian apparatus of *Carnegiella vesca* showing the back of the cranium with the left exoccipital and

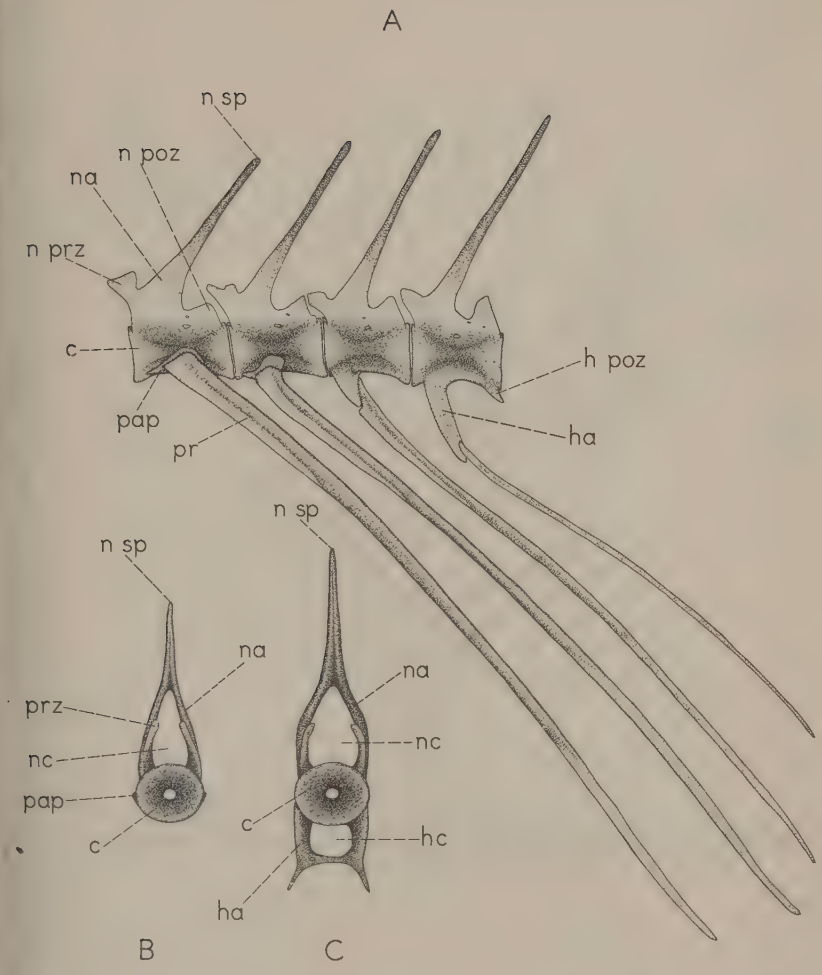

FIG. 11. Precaudal vertebrae of *Carnegiella vesca*. X 19. A. Eighth through eleventh precaudal vertebrae (lateral view). B. Eighth precaudal vertebra (anterior view). C. Eleventh precaudal vertebra (anterior view).

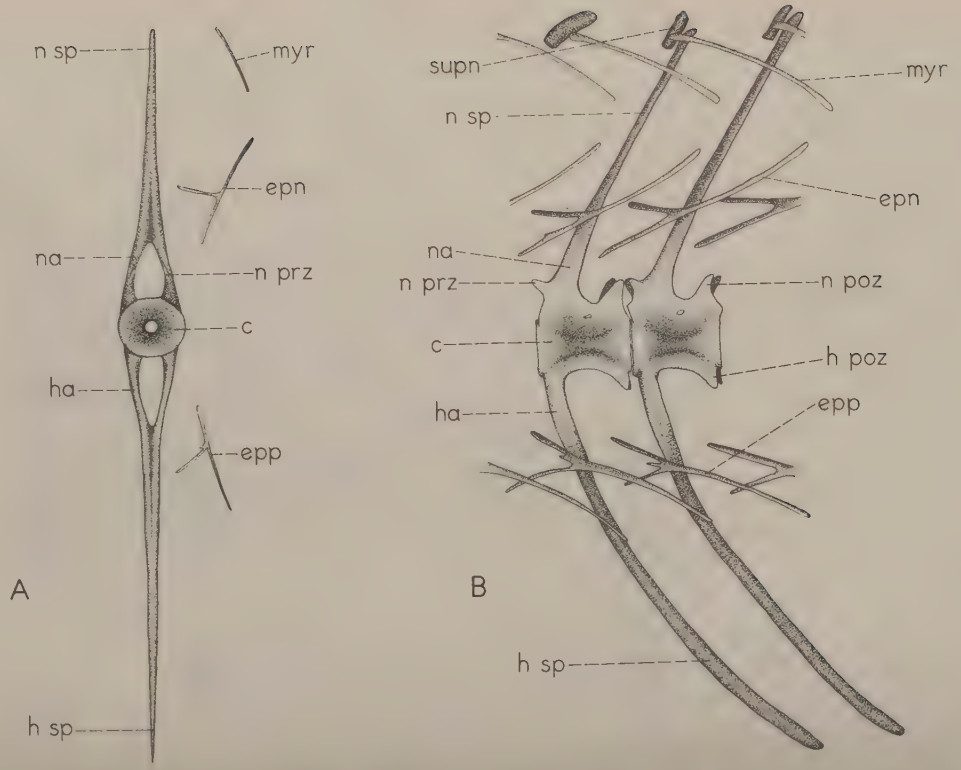

FIG. 12. Caudal vertebrae and intermuscular bones of *Carnegiella vesca*. X 19. A. Sixteenth caudal vertebra with associated intermuscular bones (anterior view). B. Sixteenth and seventeenth caudal vertebrae with associated intermuscular bones and supraneurals (lateral view).

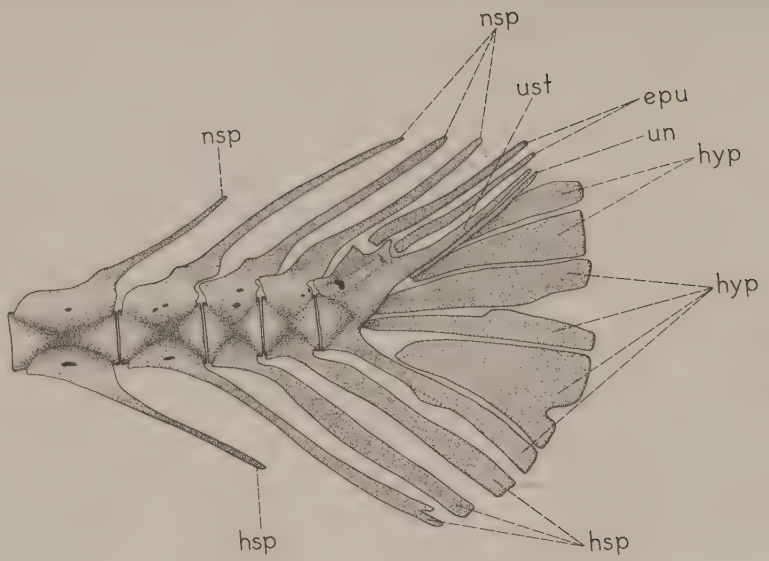

FIG. 13. Tail region of *Carnegiella vesca* showing the twenty-eightn to thirty-second vertebrae and associated structures (lateral view). X 19.

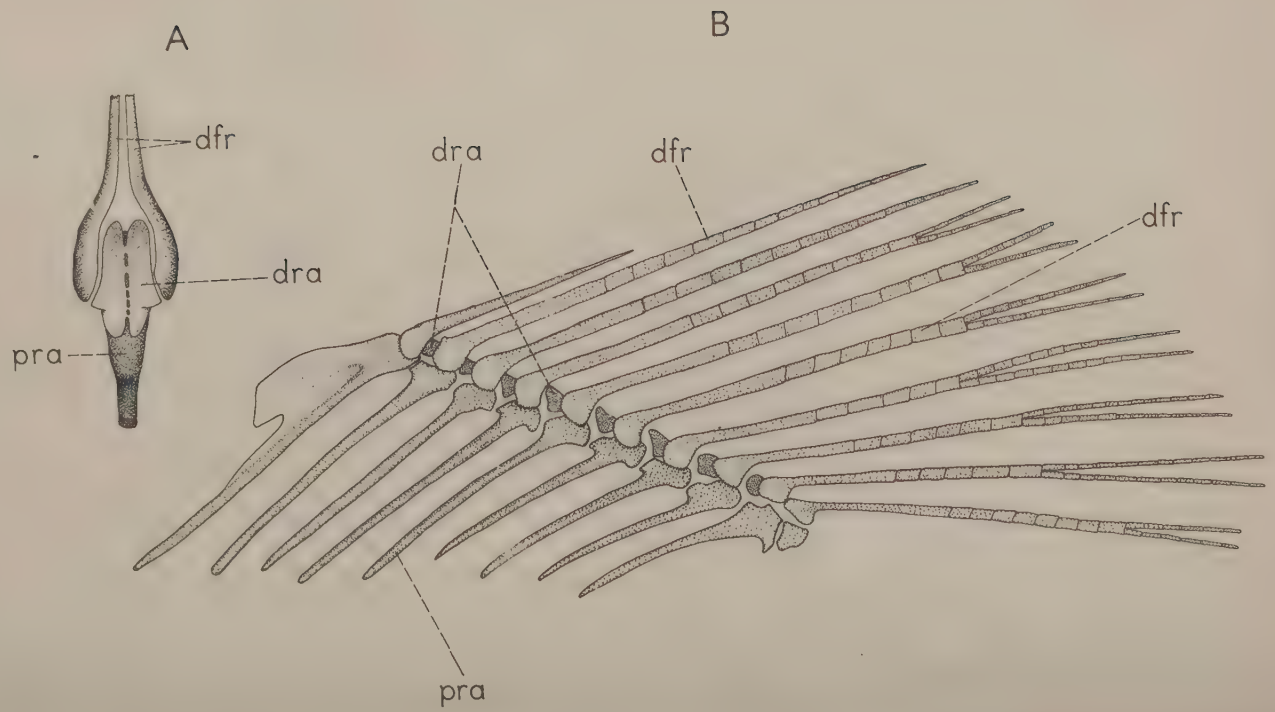

FIG. 14. Dorsal fin of *Carnegiella vesca*. A. Articulation of sixth ray (anterior view). X 80. B. Dorsal fin (lateral view). Note last ray divided to its base. X 20.

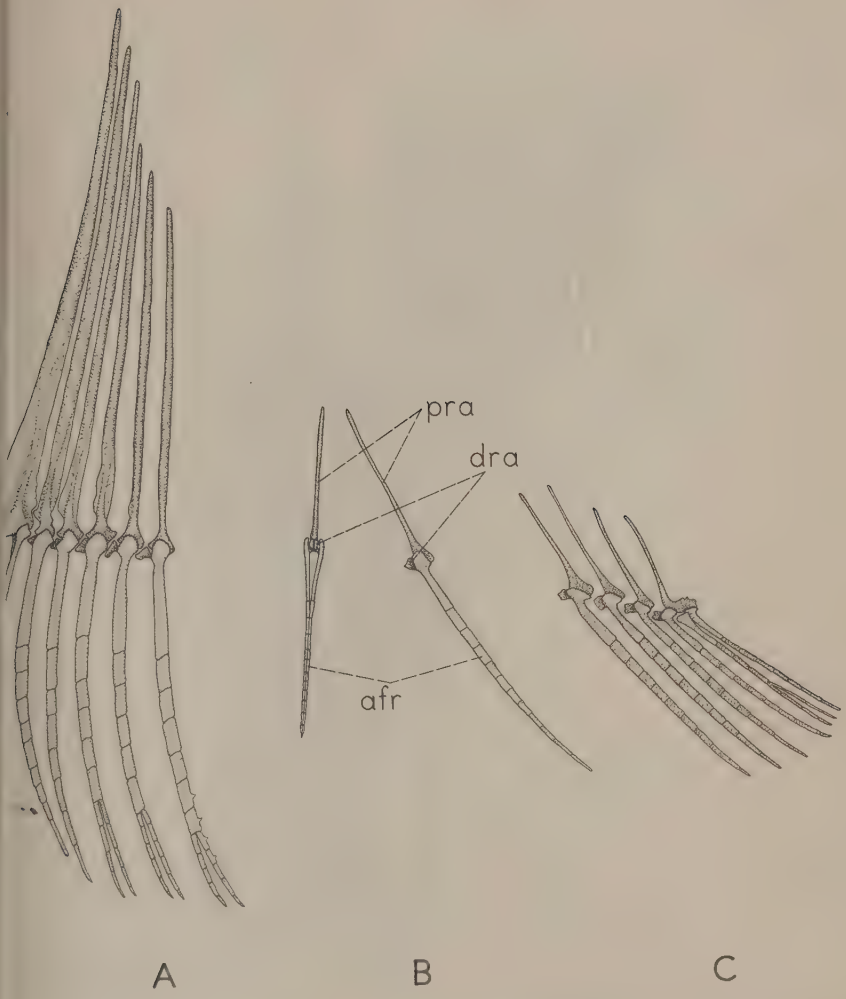

FIG. 15. Anal fin of male *Carnegiella vesca*. X 13. A. First six anal in rays and associated structures (lateral view). B. Twentietn anal fin ray and associated structures (anterior and lateral view). C. Twenty-fourth nrough twenty-eignth anal fin rays (lateral view). Note last ray divided o its base.

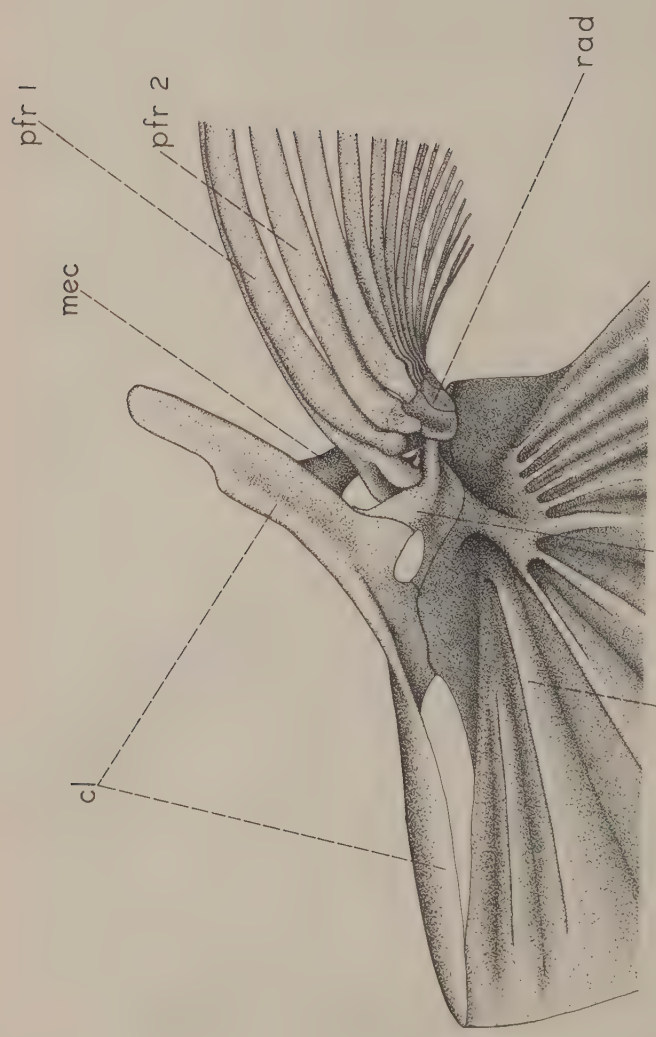

FIG. 16. Upper region of primary pectoral girdle of *Carnegiella vesca* (lateral view). X 12.

FIG. 17. Primary pectoral girdle of *Carnegiella vesca* (dorsal view). X 12.

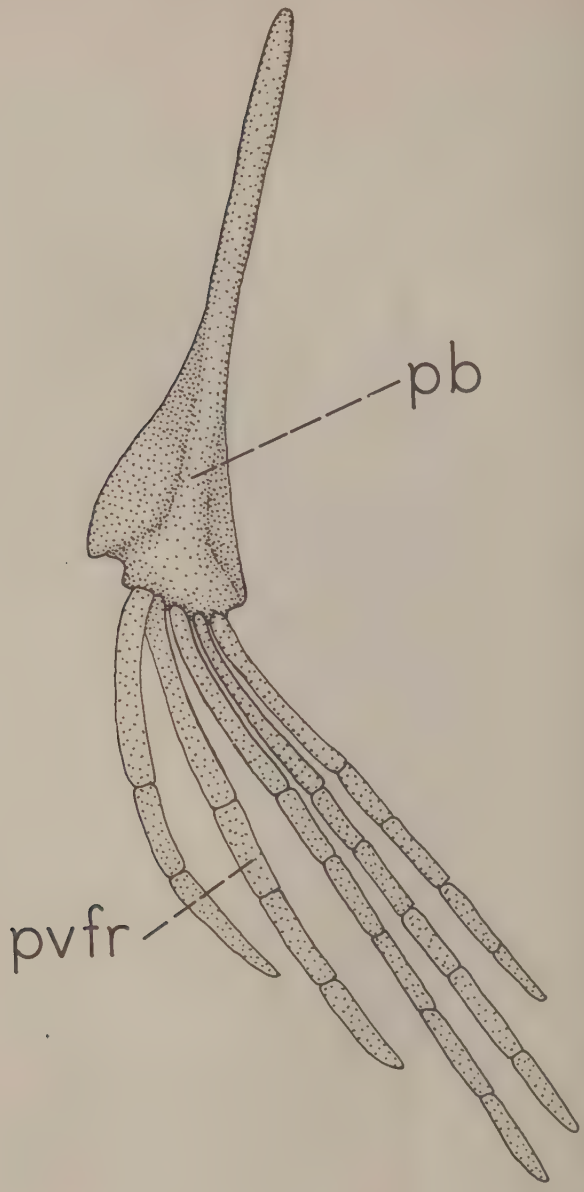

FIG. 18. Pelvic girdle of *Carnegiella vesca* (lateral view). X 45.

Abbreviations Used in Text and Figures

adnasal	
auditory foramen	
anal fin ray	
angular	
articular	
asteriscus	
basibranchial	
basihyal	
basioccipital	
branchiostegal ray	
branchiostegal rays	
centrum	
ceratobranchial	
ceratohyal	
cleithrum	
claustrum	
coracoid	
dentary	
dorsal fin ray	
dorsal hypohyal	
dorsal rib	
distal radial (pterygiophore)	
epibranchial	
epihyal	
epiotic	
epiotic lamella	
epineural	
epipleural	
epural	
exoccipital roof of cavum sinus imparis	
ethmoid (mesethmoid)	
exoccipital	
frontal	
foramen magnum	
foramen for scaphium	
haemal arch	
hypobranchial	
haemal canal	
horizontal plate	
haemal postzygapophysis	
haemal spine	
hyomandibular	
hypural	
interhyal	
intercalarium	
interopercle	
lapillus	
lateral ethmoid (prefrontal)	
lower pharyngeal	
mesocoracoid	
mesopterygoid	
metapterygoid	
maxillary	
myorhabdoi	
n	nasal
na	neural arch
nc	neural canal
ncom	neural complex
npd	neural pedicle
npoz	neural postzygapophysis
nprz	neural prezygapophysis
nsp	neural spine
op	opercle
opi	opisthotic
orb	orbital bone
osp	orbitosphenoid
oss	os suspensorium
pal	palatine
pap	parapophysis
par	parietal
pb	pelvic bone
pfr	pectoral fin ray
pls	pleurosphenoid (alisphenoid)
pmx	premaxillary
pop	preopercle
pr	pleural rib
pra	proximal radial (pterygiophore or interneural)
pro	prootic
psp	parasphenoid
pt	pterygoid
ptf	posttemporal fossa
ptm+scl	posttemporal-plus-supracleithrum
ptr	pterotic
pvfr	pelvic fin ray
pvo	prevomer (vomer)
qu	quadrate
rad	radials (actinosts)
sca	scapula
scp	scaphium
scs	scales
soc	supraoccipital
sop	subopercle
sp	sphenotic
sph	suspensory pharyngobranchials
spl	splenial
st5	sensory tube in region of circumorbital 5
stm	supratemporal (tabular)
supn	supraneural
sym	symplectic
tr	tripus
ttr	transformator process of tripus
uhy	urohyal
un	uroneural
uphs	upper pharyngeals
ust	urostyle
vhhy	ventral hypohyal

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STUDIES ON FISHES OF THE FAMILY CHARACIDAE. NO. 7. A NEW GENUS AND SPECIES OF GLANDULOCAUDINE CHARACIDS FROM CENTRAL BRAZIL

By James Böhlke

The new genus of characins described in this paper has the appearance of *Bryconamericus* but bears a caudal gland. While the possession of a caudal gland is characteristic for the glandulocaudine characids, there are several "borderline" genera (between the Tetragonopterinae and Glandulocaudinae of Eigenmann) which have one, and the question immediately arises as to the common origin of the possessors of that particular character. The "borderline" genera referred to here are *Landonia, Argopleura, Acrobrycon,* and *Pnacobrycon*, of which Myers (in Eigenmann & Myers, 1929, p. 467) thinks *Landonia* and *Argopleura* are closer to the glandulocaudines than to the tetragonopterines. No attempt will now be made to settle definitely the question of common origin of the Glandulocaudinae, but the present writer strongly doubts a monophyletic origin, especially if the above "borderline" genera are included. It seems much safer to assume, until careful comparisons of all the genera have been made, that at least some of the geographically localized and morphologically very divergent genera have arisen at different times from different members of such generalized tetragonopterines as *Bryconamericus*. An origin from a fish like *Brycon*, as suggested by Gregory (1951, p. 213), seems much less likely. Other examples of multiple origin of modified caudal scales in male characins are afforded by the Cheirodontine genera *Compsura* and *Saccoderma*.

Genus PLANALTINA, new

Generic type: *Planaltina myersi*, new species.

Description of genus largely that of its single species. The following combination of characters will serve to separate the new genus from other glandulocaudine and tetragonopterine forms:

1. Premaxillary teeth in two rows, the outer of several tricuspid and the inner with four quincuspid teeth; mandibles with several large quincuspid teeth anteriorly, followed by smaller teeth on the sides; one or two teeth anteriorly on maxillaries.
2. Origin of dorsal fin slightly behind midpoint of standard length, larger eye than caudal base and slightly anterior to a vertical with origin of anal fin.
3. Males with scaly caudal pouch on lower lobe of fin, and hooks on ventral and anal fin rays.
4. Lateral line complete, little decurved.
5. Predorsal and preventral scalation normal.
6. No procumbent dorsal spine, elongated scales, prolongation or notching of opercles, or caudal spur.
7. Great suborbital in contact with suboperculum below, leaving a narrow naked margin behind.
8. Preventral area not trenchant, more or less narrowly rounded.
9. Anal fin rays v,20.
10. Mouth oblique.

Relationships: Possessing notched, biserially arranged premaxillary teeth and a caudal gland (on the males), the new genus must be compared with those placed by Eigenmann and Myers (1929) in the Glandulocaudinae, and with the "borderline" genera mentioned in the introduction. The above combination of characters should serve to exclude *Planaltina myersi* from any of the genera placed by Eigenmann in his subfamily Glandulocaudinae; however, it would run down to *Hysteronotus* Eigenmann (1911, p. 171) if keyed out in Eigenmann and Myers (1929, p. 467). It is clearly not that genus because of the following distinguishing features:

1. Teeth four in inner series of premaxillary, rather than five or more ("6 or 7" under specific description by Eigenmann in Eigenmann & Myers 1929, p. 486).
2. Origin of dorsal nearer to eye than caudal base and slightly anterior to that of anal, rather than "...origin of dorsal nearer to caudal than to eye, considerably behind the vertical from the origin of the anal..."[1]
3. Inner premaxillary and anterior mandibular teeth quincuspid, rather than "...all the teeth except the last ones on the dentary *tricuspid*..."
4. Fontanels wide, versus "...fontanels reduced to a just perceptible slit except at the base of the occipital process..."
5. Anal v,20, rather than 35-36.
6. Predorsal scales about 15, rather than "...about twenty-five..."
7. Pectorals failing to reach ventrals, versus "...pectorals large, falcate, sometimes reaching to the anal..."
8. No humeral bar, rather than "...a well-developed humeral bar..."

Hysteronotus is closest to the new form, geographically, as a reference to Figure 1 will clearly illustrate. The Rio Preto, shown on the map, is an affluent of the São Francisco, as is also the Rio das Velnas which is the type locality of *Hysteronotus megalostomus*. However, in spite of their close geographical proximity, the two forms are shown to be completely distinct by the differences listed above.

Since the degree of separation of the lower caudal fulcra to form a spur is somewhat variable in some forms of *Gephyrocharax*, the *Planaltina* may warrant a brief comparison with that genus. In addition to the absence of a spur, the new form does not agree with *Gephyrocharax* because of (1) origin of dorsal nearer eye than caudal base and slightly anterior to that of anal, rather than "Origin of dorsal nearer to caudal than to the eye, considerably behind the vertical from origin of anal;" and (2) anal v,20 rather than 26-33.

After showing that the new genus cannot be closely allied with any of the true glandulocaudines, it next will be compared with forms that the present writer feels are closer to it in level of differentiation, evolutionarily speaking, such as *Argopleura* Eigenmann and the other "borderline" genera. This closeness does not necessarily imply immediate common ancestry but only a similar degree of alteration in these genera from the generalized tetragonopterine state.

Landonia Eigenmann and Henn (in Eigenmann, Henn, & Wilson, 1914, p. 1) is immediately separable from the new genus because of the extremely different dentition. Other characters which place the two at variance are:

1. Anal rays v,20 in *Planaltina*, 31-32 in *Landonia*.
2. Lateral line scales 41 or 42 in *Planaltina*, 45-50 in *Landonia*.
3. Gill rakers 6+10 or 11 in the new genus, 17+8 in *Landonia*.
4. The very different anal fin armature and caudal gland structure of males of the two forms.
5. Their geographical distribution as indicated on Figure 2.

The new genus differs from *Phenacobrycon* Eigenmann (1922, p. 147) in many respects, among which are:

[1] Where quotes are given without reference to their source they are taken from Eigenmann (1927) or Eigenmann and Myers (1929).

. .Male hooks on last unbranched and first ten branched anal rays, ter than "...first ten and last ten developed rays of the anal of the l with hooks..."
Anal rays v,20, rather than 33.
Anal of male not lobed, with a nearly straight margin, versus "...anal ate, the last ten rays in the male forming a second lobe..."
. Pectorals not reaching to ventrals, rather than "...pectorals at at to ventrals..."
. Gill rakers 6+10 or 11, rather than 12+11.
. Frontal fontanel long, wide, completely separating frontals, versus ..parietal fontanel much longer and wider than the frontal..."
. Different structure of the caudal gland (for this, see also Tortonese, -42).
. The very different geographical distribution as shown on Figure 2.
From *Acrobrycon* Eigenmann and Pearson (1924, p. 44), a specialized mbrycon, *Planaltina* differs in the following respects:
. Anterior mandibular teeth quincuspid, rather than tricuspid.
. One or two tricuspid teeth at anterior end of maxillary, rather than .with eight or nine teeth, the upper ones tricuspid, the lower one or s conical..."
. Anal rays v,20, rather than 32.
. About 15 scales in front of dorsal fin, rather than "about 23..."
. Three teeth in outer series of premaxillary, rather than four or five.
. The very different geographical distribution as shown on Figure 2.
Acrobrycon, however, does have complete frontal separation and black ile caudal rays, in company with the new genus and in contrast with the er three.
Planaltina is closest to *Argopleura* Eigenmann (1913, p. 10) in structur- characteristics. It differs sufficiently from the members of that genus, ever, both morphologically and distributionally, so as to warrant the ction of a new genus for its sole reception. The principal differences ween the two are:
1. Male hooks on last unbranched and first ten branched anal rays, rath- than "...strongest on a circular patch covering part of (about) the tenth the fifteenth rays..."
2. Anal short, with v,20 rays, rather than having 29-45 rays.
3. Lower caudal fulcra following ventral outline of caudal fin rather n "...frequently prominent, separate from the rest..."
4. Evidently a slightly more extensive frontal fontanel development.
5. The very different geographical distribution as shown on Figure 2.
The anal ray count of *Planaltina* is the lowest of the subfamily, except *Pterobrycon landoni* Eigenmann, *Glandulocauda melanopleura* Eigenmann, *Corynopomops opisthopterus* Fowler. However, all three of these are so ferent, morphologically, that no direct comparison of them with the new m is warranted.

Planaltina myersi, new species
(Figure 3)

Holotype: SU 18636, a male, 36.8 mm. in standard length; collected by Carl Ternetz from "Sarandi brook, Planaltina, Goyaz, Brazil"; September , 1923. With the aid of other Ternetz collecting localities at about at date, the above locality is placed as a small brook somewhere along e Chapadão do Sarandy, lying between the headwaters of the Rio Maranhão hich empties into the Tocantins) and those of the Rio São Bartholomeo hich empties into the Corumbá and then into the Paranaanyba). Thus, the rticular brook which Ternetz collected may drain into either the great

FIG. 1. An enlarged map of the type locality of *Planaltina myersi*. least three great river systems have headwaters in this area.

FIG. 2. The known distribution of *Planaltina* and the "borderline" genera ferred to in tne text: 1. *Argopleura*; 2-3. *Landonia* and *Phenacobrycon*; *Acrobrycon*; 5. *Planaltina*.

Amazonian system to the north or into the Paraná to the south—but more likely the latter, since on the Millionth Maps of Hispanic America the Chapadão do Sarandy is closest to the São Bartholomeo, being separated from the most part from affluents of the Maranhão by the Chapadão do Torto. Ternetz' "Sarandi brook" would, then, lie somewhere in the vicinity of 15° 40' South Latitude, 47° 45' or 50' West Longitude. See Figure 1 which illustrates the close proximity of certain headwaters of three very large river basins to each other—the Rio Tocantins, Rio Paraná (of the south), and Rio São Francisco. It should be noted that the Rio Paraná shown on Figure 1 is not the great Paraná of the south but rather a tributary of the Tocantins; the Rio Corumbá of the map joins the great Paraná farther south. These headwaters may permit faunal interchange during periods of high water.

Collected with dynamite, which apparently caused damage to the gut region of the specimen.

Description: Body elongate, slender, much compressed laterally. Anterior end of fish bent sharply upward at a point midway between tip of snout and origin of dorsal fin; possibly the head bends upward slightly in life but most likely not to the extent shown by the present specimen. This specimen was probably either anomalous or injured by the dynamite blast at the time of collection. The body was bent into a supposed normal position when the following measurements were made: standard length, tip of snout to origin of dorsal fin, tip of snout to adipose dorsal fin, tip of snout to base of ventral fins, tip of snout to origin of anal fin.

Head short, its dorsal and ventral outlines approximately similar. Snout short, rounded, shorter than eye. Interorbital convex, width less than diameter of eye. Eye moderate in size, lateral, not entering dorsal profile. Great suborbital large, nearly covering cheek, but leaving a narrow naked strip behind the posterior margin. Three postorbitals, of which the uppermost is very small. Middle postorbital largest, with twice or more than twice area of lowermost, all postorbitals leaving naked region between their posterior ends and vertical limb of preopercle. Mouth moderate, oblique, the rather long and narrow maxillary not quite reaching suture between second and third suborbitals. Maxillary teeth tricuspid, rather broad, one on the left side, two on the right. Premaxillaries with two rows of heavy, broad teeth; three tricuspid teeth in each outer row and four quincuspid teeth in each inner series. Mandibular teeth in single series on each side as follows: four quincuspid teeth in front, similar to those of inner series on premaxillary, these followed by several smaller conical teeth which decrease in size posteriorly (left side); four quincuspid teeth, then a single tricuspid tooth, with only five conical teeth posteriorly (right side). No teeth on vomer or palatines. Fontanels extensive: parietal fontanel widest at base of occipital process; frontal fontanel complete, widest posteriorly, the lateral boundaries not meeting even in front. Gill rakers 6+10 or 11, the rakers short, pointed, and rather widely spaced.

Origin of dorsal posterior to midpoint of standard length but just slightly in advance of that of anal fin. Dorsal fin not very high, its height measured from base of first ray to tip of longest ray shorter than length of head; outline of fin rounded. Adipose fin well developed, placed far posterior, behind a vertical with base of last anal ray. Pectoral fins rather long, narrow, placed low on body, their tips failing to reach base of ventrals. Ventral fins short, their tips not reaching to anal fin origin. Numerous fine, scarcely recurved, paired spines along all branched rays of ventral fins, this being a male sexual characteristic. Anal fin without anterior lobe, margin of fin nearly a straight line. Hooks present on anterior rays of anal fin, also a male sexual character. Hooks on posterior margins of fin rays paired (except that several smaller, medial posterior nubbins are often present distal to the paired hooks on the se

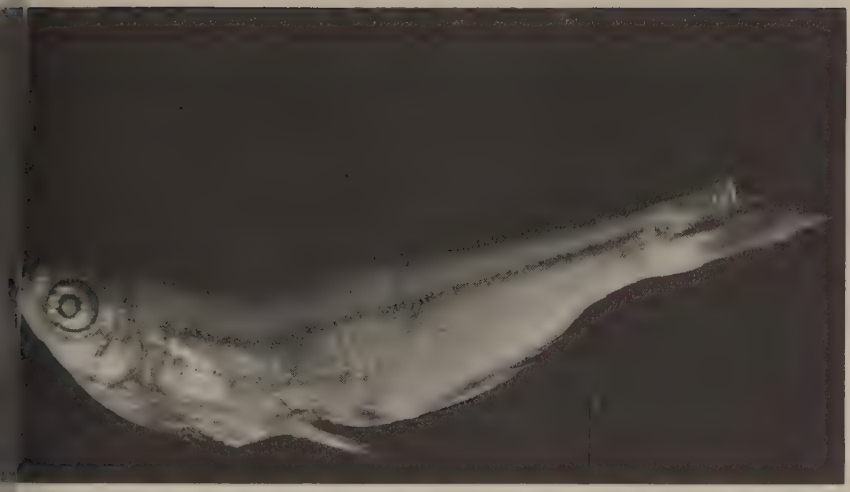

FIG. 3. Holotype of *Planaltina myersi*, SU 18636; standard length 36.8 mm. Photographed by Stanley Weitzman.

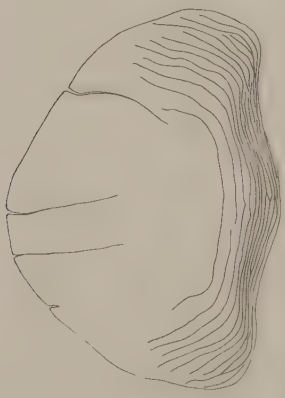

FIG. 4. Scale from the holotype of *Planaltina myersi*, taken from area between lateral line and dorsal fin.

eral anterior rays). Hooks placed one pair per ray segment, usually jus distal to longitudinal midpoint of segment. "Hooks" simple nodules c short, blunt spines projecting outward perpendicular to main axis of ray c the more anterior rays bearing them; becoming larger, more recurved, an decidedly "hook-like" farther back. These hooks recurved proximally toward the bases of the rays. Hooks present on last unbranched and firs ten branched anal rays, farthest out on rays anteriorly, becoming confine more proximally posteriorly. On each ray the number of segments bearin hooks as follows (counting as a single segment those adjacent elements sep arated by the splitting of the ray, even though each member of the segment pair often bears its own hooks): last unbranched, 6; first branched, 5; second branched, 2; third branched, 2; fourth branched, 2; fifth branched, 2; sixth branched, 3; seventh branched, 3; eighth branched, 2; ninth branched, 1; tenth branched, 1, much smaller than those on the several rays just preceding.

Scales cycloid, smooth, strongly adherent, with few radii and fine but not overly numerous circuli (see figure 4). Sheath of scales along base of anterior portion of anal fin one and one-half scale rows wide in front, a single row in width behind, continued back to about base of ninth branched ray. Lateral line complete. Predorsal scalation complete, nearly regularly a median row with but few interpolated scales to interrupt it. Preventral and pre-anal regions rounded with a median, though not completely regular, series of normal scales. One and one-half scales bordering occipital process on either side. A rather complete scale arrangement covering basal portion of caudal fin—the so-called "caudal gland" of male glandulocaudines. While several scales at base of upper half of fin have enlarged and specialized shapes, the gland itself is on the lower half. Scales jutting back more than half the length of midcaudal rays, just below midpoint of fin. Below this the scaled portion is cut back strongly (anteriorly), and then curves slightly back again in the region of the spur of *Genhyrocharax*. Lowermost caudal rays not separated as a spur, but continuous with ventral outline of lower caudal lobe. Caudal fin not split to the base medially.

Color in alcohol: Base color light tan. Trenchant midlateral silvery band of uniform width, equal to about two-thirds diameter of eye. Lateral band also liberally sprinkled with melanophores which are concentrated most strongly to a horizontally elongate oval spot on caudal peduncle. This caudal spot continued out on midcaudal rays to their tips, but strongest on basal half of rays. Lighter peppering of melanophores on remainder of caudal fin, strongest on upper lobe. Concentration of black pigment cells along dorsal midline, over top of skull, snout, tip of lower jaw, and outlining body scales above midlateral stripe. Scattered melanophores on pectoral fins, but not arranged into any discernible pattern. Interradial membranes of anal fin rather dotted with melanophores, this coloration strongest along basal halves of anterior branched rays; no definite spot obvious. Similar dotting present along basal half to two-thirds of both margins of each of the dorsal rays. Opercles and circumorbital bones silvery.

The generic name *Planaltina* refers to the Planaltina where this fish occurs. I take great pleasure in naming the species for Professor George S. Myers in appreciation for the ichthyological understanding I have gained working under him these past years, and in recognition of his interest in the group to which the new species belongs.

The counts, proportions, and measurements of the type specimen are presented on the accompanying table.

Table 1

Counts and Measurements of the Holotype
of *Planaltina myersi*

ts	
orsal fin	ii,8
nal fin	v,20
ectoral fins	i,10-i,10
entral fins	i,6-i,6
audal fin	i,17,i
cales in lateral line	41 or 42
cales above lateral line	6
cales below lateral line	5
redorsal scales	ca. 15
ill rakers	6+10 or 11

esurements	In Millimeters	Proportion in Standard Length
tandard length	36.8	1.0
reatest depth of body	9.1	4.0
ip of snout to origin of dorsal	20.0	1.8
ip of snout to origin of anal	21.5	1.7
ip of snout to base of pectoral	9.4	3.9
ip of snout to base of ventral	17.0	2.2
ip of snout to adipose dorsal	30.8	1.2
orsal origin to anal origin	21.5	4.1
east depth of caudal peduncle	4.0	9.2
ength of caudal peduncle	6.6	5.6
ength of head	8.6	4.3
ength of pectoral fin	7.7	4.8
ength of ventral fin	5.3	6.9
eight of dorsal fin	7.3	5.0
eight of anterior anal rays	5.2	7.1

		Proportion in Head Length
Diameter of eye	3.2	2.7
Length of snout	2.4	3.6
Tip of snout to end of maxillary	3.7	2.3
Least width of interorbital	2.7	3.2

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CALLECHELYS CLIFFI, A NEW OPHICHTHID EEL FROM THE GULF OF CALIFORNIA

By James Böhlke and John C. Briggs

In the spring of 1953, a group of biologists from Stanford University oarked on a four week collecting trip to the Gulf of California aboard te research ship *Orca* of the Sefton Foundation. This trip was the second fton Foundation expedition to the Gulf with Stanford personnel on board, fe first having taken place over a two and one-half month period during e spring of 1952. Mr. Joseph W. Sefton of San Diego, California, once re very generously supplied the ship and facilities for the expedition, d since each of the present writers carried on the ichthyological inves- gations during one of the trips (Böhlke in 1952; Briggs in 1953) they re offer their joint appreciation of the opportunity.

It was on the 1953 trip, while anchored in Fraile Bay, that Mr. Frank S. iff (herpetologist on the expedition) sighted a small eel swimming past e ship on the surface in broad daylight. Picking up a long-handled dip- t, he scooped up the fish, and Briggs informed him that if the eel were described it would be named for him. After examination back at Stanford, was found that the eel was indeed a new species, and the writers now ve the privilege of naming it for Mr. Cliff.

Callechelys cliffi, new species
Figures 1 and 2

Holotype: Stanford No. 47521, 93.5 mm. in total length; collected by ank S. Cliff in Fraile Bay, just south of Los Frailes, Baja California, exico: 23° 22' 20" North Latitude, 109° 24' 40" West Longitude; surface ver eight fathoms, 350 yards from shore; March 19, 1953; bottom, large oulders interspersed with live coral heads; surface calm. Specimen juve- ile or adolescent, with all of the fin rays easily visible and the body till retaining some of the larval pigmentation. If proportional discrep- ncies are found between figures and text, the text should be accepted as orrect.

Description: Body elongate, strongly compressed, with dorsal and vent- al body outlines parallel to posterior part of tail, from where they taper venly to a sharp, finless point. Gut distended with much food material, ts greatest depth 21.3 times in total length; depth just anterior to full ut region 26.7 in length; depth at anus 30.2 in length; depth at gill op- nings 28.3 in length. Anus posterior to midpoint of total length, its istance from tip of snout 1.8 in total length.

Head long, its length 5.6 in length of head and trunk combined, 9.9 in otal length. Dorsal profile of head evenly rounded from occiput to tip of nout. Eyes lateral (not entering dorsal profile), small, 13.4 in head, overed by skin, only very slightly protruding, readily visible from the xterior, placed nearly equidistant from tip of snout and angle of jaw, heir anterior margins posterior to a line across tip of lower jaw. Snout ong, rounded dorsally, with a bluntly rounded tip, flattened below, great- ly produced beyond lower jaw, its length contained 5.9 in length of head. Interorbital convex, its width 11.8 in length of head. Tubular anterior ostril thick-walled, opening of tube with two opposed papillae on its lat- eral margins, which project into the opening and give it an hour-glass

shape. Distance from midpoint of tip of snout to anterior nostril 18.8 i head. Posterior nostril included within flap on upper lip, the center which lies directly below anterior margin of pupil. Lower jaw shor pointed, its entire border contained within outlines of head when view from below. Distance from tip of snout to angle of mouth 2.9 in length head. Midpoint of upper jaw deeply incised, leaving an open triangul area and exposing several teeth between front of upper lip and tip of lo jaw when mouth is closed (from a ventral view). Teeth depressible bac wards, one or two large teeth on each intermaxillary; maxillaries and ma dibles each with a single series of smaller, close-set teeth; vomeri teeth biserial, four or five teeth in each row. Gular region witho strong longitudinal folds; jugostegalia present, those of right side ove lapping those on left at ventral midline. Gill openings small, low, dire ted diagonally upward and back from a side view; angle of gill openi about 135°. Openings only slightly curved when viewed from below, t straight distance between the two ends of an opening contained 7.2 in hea Isthmus narrow, equal to diameter of eye, 13.4 in length of head. Pecto fins completely lacking. Approximately 50 middorsal rays in a section fin equal to length of head.

Table 1

Measurements	In Millimeters	Percentage Total Leng
Length of head	9.4	10
Length of head + trunk	53.0	57
Length of trunk	43.6	47
Length of tail	40.5	43
Depth of body at gill openings	3.3	4
Depth of body at point of greatest fullness of gut	4.4	5
Depth of body just before point of greatest fullness of gut	3.5	4
Depth of body at anus	3.1	3
		Percentage Head Leng
Diameter of eye	0.7	7
Length of snout	1.6	17
Width of interorbital	0.8	9
Width of head at occiput	2.8	30
Tip of snout to tip of lower jaw	1.2	13
Tip of snout to anterior nostril	0.5	5
Tip of snout to angle of mouth	3.2	34
Width of gill opening	1.3	14
Width of isthmus	0.7	7
Tip of snout to origin of dorsal	5.7	61

Lateral line system well developed on both head and body. Lateral l opening to surface through about 149 pores projecting from lower surface lateral line canal (this figure includes those of arch over branchial gion). Supraorbital branch of lateral line system on head opening b single pore above eye on interorbital space, and two pores in line with in front of eye on snout; suborbital canal displays two pores behind e

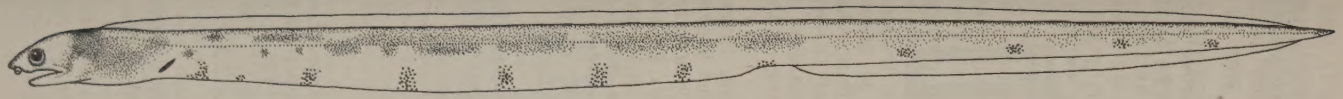

FIG. 1. Lateral view of the holotype of *Callechelys cliffi*, SU 47521; 93.5 mm. in total length.

FIG. 2. Head region of the holotype of *Callechelys cliffi*. Distance from tip of snout to anterior end of gill opening 9.4 mm.

three pores in a line below eye and behind posterior nostril, one pore be tween nostrils, and a single pore before each anterior nostril; mandibula branch opens by two pores behind rictus of mouth, and, continuing forwar in line with these, bears five pores on underside of either mandible; th remaining pores are a median pore behind eyes, a median pore on occiput and a supratemporal pore on either side of head.

Color in alcohol: Body and head strongly marked with brown splotches o a cream-colored background, the coloration characteristic of other member of the genus *Callechelys*. These blotches closest together and coverin more of the body surface anteriorly, diminishing gradually posteriorly. There are also 12 somewhat diffuse blackish spots equally spaced on trun and tail (a lesser concentration of melanophores between major spots on and two might be construed as a thirteenth spot); the seven (or eight trunk spots are ventral in position, the seventh surrounding the anus; fiv tail spots placed up from ventral surface, just below midlateral body axis the last at very tip of tail. Spots on tail nearly perfectly round, thos on trunk elongated laterally (middle ones longest) so as to extend upwar slightly onto sides of fish. This color pattern probably developed fro larval coloration such as that exhibited by Fowler's *Leptocephalus carib baeus* (1944, fig. 49); by his *L. decimpunctum, lucillae,* or *tredecimpunctu* (1938, figs. 5-10); or by several of the stages depicted by Grassi (1913 Tav. 6, figs. 1-12) for *Ophisurus (Ophichthus) serpens*. Thus, what is be lieved by the present writers to represent the retention of larval pigmen tation in an eel sufficiently developed to be definitely assigned a generi name may mark one step toward the eventual goal of matching up the larva and adults of eels.

Relationships: In her revision of the genus *Callechelys*, Storey (1939 recognized seven species. Of these, *C. muraena* Jordan and Evermann fro the Gulf of Mexico apparently most closely approaches the new species, bu the two are distinct. *Callechelys cliffi* has a longer head, greater depth shorter trunk, longer tail, and the origin of the dorsal fin is more poste rior. The new species is the first known member of the genus from th Pacific coast of the Americas and marks the high extremes for length o head and depth of body in the entire genus. While several of these di tinctions may be a product of the juvenile state of one holotype, there no described species to which we can assign this specimen.

This new species is one of the large group of eastern Pacific forms ha ing cognates in the tropical Atlantic, rather than originating from Ind West Pacific stock.

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